Student Teachers Supporting Primary Science: Project Report

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Contents

Introduction

The 'Student Teachers Supporting Primary Science Project' sought to simultaneously address two problems which constrain the pre and in-service phases of science teacher education. The first problem is that during the school placement phase of ITE programmes, student teachers often have very limited opportunities to observe or teach science lessons due to the low profile of science within the primary school curriculum. Scholars of teacher education concur that effective ITE programmes must provide scaffolded and supportive classroom experiences in which student teachers can begin to apply the knowledge and theory acquired throughout the other areas of the programme. While this problem of enactment requires student teachers to move from thinking like teachers to acting as teachers relates to the teaching of all curricular areas, it is particularly challenging in primary science where managing practical activities and adopting more pupil-centred approaches can be very challenging to novices. Graduates with little experience of science during their pre-service training are more likely to offer a limited repertoire of science lessons during their professional career. The problem that relates to the in-service phase of teacher education is that resource, budgetary and time restrictions limit the availability of professional development for teachers. Where there is training, the focus tends to be on numeracy, literacy or wider issues such as assessment or pastoral care. In-service training in primary science usually takes the form of a one-off event or course, is usually held off-site, and rarely tailored to suit the immediate needs of a teacher's particular teaching context.

This projects explored whether student teachers could be encouraged and supported to teach science during their school placements and if these lessons could serve as both a resource and a stimulus for developing their host teacher's future teaching. We have previously reported on the merits of involving student teachers in school-based curriculum development projects (McCullagh & Doherty 2021; Earle & McCullagh 2020; McCullagh & Doherty, 2018). These projects have involved up to 20 primary specialist student teachers planning and teaching primary science in a small number of local primary schools. The students and teachers worked together to develop and evaluate teaching strategies and resources, which can continue to support in-service teachers long after the project is completed. Our evaluations of this work have consistently reported a huge increase in student teachers' ability, confidence and capacity to teach primary science and evidenced the benefits to our partner schools. In this 'Student Teachers Supporting Primary Science Project' we aimed to explore if two entire cohorts of student teachers (not just science specialists) could add to the science provision of a more significant number of primary schools while simultaneously developing their own practice in primary science. We sought to explore if this potential 'win-win' deployment of pre-service teachers could prove effective on a larger scale and thus address the current demise of primary science in our schools.

Project Rationale

The importance of science in the primary school

A key role of science within the primary curriculum is to secure a strong foundation for a scientifically literate society (OFSTED, 2013). Developing the scientific literacy of primary school pupils is undoubtedly more important than ever in a world coping with the Covid-19 global pandemic and the existential threat posed by the unfolding climate emergency. The rationale based on the value of science education to both the individual and society has never been sounder in an age where sustainable lifestyle choices and compliance with public health advice are essential for the survival of one and all. Furthermore, living in the era of 'fake news' where evidence and the opinion of experts are often treated with suspicion, possessing a critical faculty and the ability to think scientifically are equally important. Therefore, it is crucial that children not only have the opportunity to engage with important scientific ideas and phenomena but that they also conceptualise science as a disciplined process of enquiry whereby theories can be developed and tested.

Murphy *et al*. (2011) argue that primary science has the potential to spark children's interests in the sciences and if their first formal educational experience of science is positive, it can inspire them to study science beyond the statutory curriculum (Wellcome Trust, 2014). Moreover, it has been noted that attitudes to science form early (The Royal Society, 2010) with most students already excluding the choice of scientific subjects during their primary years (Osborne and Dillon, 2008). For this reason, ASPIRES (2013) stress that relying on secondary schools to deliver a good science education "is likely to be too little, too late" (p.4). Hence, greater emphasis needs to be placed on the very best science teaching, in terms of quality and quantity (CBI, 2015) during the primary phase.

Enquiry-based science

The study of science should involve much more than simply the understanding of facts. The Royal Society (2010) proposes that teaching which prioritises the development of science and research skills increases scientific literacy and provides the stretch and challenge required to engage the scientists of the future. Furthermore, the Confederation of British Industry (CBI, 2015) recommend that science should be introduced at primary level in order to nurture pupils' interest from an early age. Harlen (2014) identifies how an enquiry based approach to teaching is naturally aligned to how children learn:

- Children are forming ideas about the world around them from birth and will use their own ideas in making sense of new events and phenomena they encounter;
- Direct physical action on objects is important for early learning, gradually giving way to reasoning, first about real events and objects and then later about abstractions;
- Children learn best through mental and physical activity, when they work things out through their own thinking in interaction with adults or other children, rather than receiving instruction and information to memorise;
- Language, particularly discussion and interaction with others, has an important part in the development of reasoning skills and ideas.

The benefits of an enquiry- orientated approach to learning reach beyond just science education. The curiosity and sense of purpose established by an aptly crafted enquiry activity provides the engagement and motivation for even the youngest of learners to begin to learn about learning (Harlen,2011). Within the rubric of enquiry, it is the engagement with activities and tasks, which develops pupils' skills. Furthermore, these tasks provide a context and a personal experience on which to reflect on the goals of the activities, discuss progress and consider other's opinions and feedback. This metacognitive thinking allows for greater personal independence and leaner autonomy.

Enquiry-based science lessons also provide opportunities for the development of pupils' personal capabilities and thinking skills. Murphy et al (2013) report on how setting enquiry within the context of a children's storybook promotes cognitive acceleration. Each of the 'five pillars of cognitive acceleration' as identified by Adey et al (2003) (Concrete Preparation, Cognitive Conflict, Social Construction, Meta-cognition, and Bridging) were matched to each of the stages of the science enquiry (Murphy et al, 2013).

Despite the allure of simultaneously developing pupils' subject knowledge and investigative skills, teaching science through enquiry does present many challenges. An enquiry-based approach can require more time and resources than may be available, and may prove difficult to align with the curricular topic and required form of assessment (Harlen, 2011). Teaching through enquiry requires a particular form of science teaching and may be avoided if teachers do not feel sufficiently confident or competent in their practice (Goodrum et al., 2001; Keys, 2005).

Primary science in the UK

Reflecting on the reported decrease in the profile of science within the primary curriculum, Alexander (2010, p.493) stated that "science is far too important to both a balanced education and the nation's future to be allowed to decline in this way." Over ten years later, concerns persist that Science and Technology has become less of a priority in schools in England, Wales and Scotland, with too little teaching time set aside for this area of the curriculum (CBI 2015). The report (p.15) states that, "half of those surveyed said that science had become less of a priority at primary school over the last five years… science is being squeezed out with numeracy and literacy pressures." The Welcome Trust's State of the Nation Report of UK Primary Science Education (2017) examined leadership and management of science, the delivery of science, and teachers' confidence in teaching science. It found that science is considered less important than literacy and numeracy and so features in a smaller proportion of school development plans with science leaders receiving less release time to lead science. The time allocated to teaching science is also much lower than for literacy and numeracy and decreases for younger learners and not all teachers feel supported and confident in science. It did note that teacher confidence was higher in schools, which had a science leader.

The Welcome Trust's State of the Nation Report of UK Primary Science Education (2017) examined leadership and management of science, the delivery of science, and teachers' confidence in teaching science:

1. Leadership

• 51% of science leaders get specific release time to lead science.

• 30% of schools' senior leadership teams think science is very important (83% for English and 84% for Mathematics).

• 60% of schools report that science is included in their school development plan.

2. Delivery

• 75% of schools deliver science lessons on a weekly basis to all year groups.

• On average science is taught weekly for an average of 1.4 hours, with lower year groups receiving less than older groups.

• 65% of teachers agree or strongly agree that they feel supported by their school to teach science.

3. Confidence

• 79% of teachers agree or strongly agree that they feel confident in teaching science.

• Schools where there is a science leader are more likely to have confident teachers.

Ofsted (2019) identified weaknesses in science provision in comparison to English and mathematics. *'Science has clearly been downgraded in some primary schools.'*

Primary Science in Northern Ireland

In Northern Ireland there are also concerns about the profile of science and technology within the primary school curriculum. The merging of Science and Technology with History and Geography under the Area of Learning called 'The World Around Us' has been reported (Johnson, 2013) to have reduced its profile in the primary school, with "90% of teachers spending less time teaching science than four years ago [prior to curricular reform], and over 50% saying it had decreased substantially, leading to a reduction in science content and topics being taught" (p.9). The Education and Training Inspectorate's survey (2015) of science and technology provision within the 'World Around Us' considered that Science and Technology was underdeveloped in 54% of schools sampled and that "provision focussed on low-level factual learning within isolated topics and lacked purposeful investigative experiences for children" (p.37). The most alarming statistic was that 28% of teachers sampled in NI did not feel confident teaching Science and Technology (ETI 2015), in contrast to only 5% for History and 4% for Geography. The report also highlights the lack of professional development for teachers in science and technology and the focus on Numeracy and Literacy as contributing factors. The report's recommendations refer to all science education stakeholders bar initial teacher education institutions. Parry et al's (2019) consideration of 'where has all the science gone?' suggests a wide range of measures to support primary science, including in-service training, changes to the curriculum content and assessment, but also does not include initial teacher education.

Initial Teacher Education

The need for more research into what constitutes an effective initial teacher education programme has been made frequently (Hiebert et al. 2007; Darling-Hammond, 2010; Burn & Mutton, 2015; Philpott, 2014; Carter, 2015; Tatto &Furlong,2015; Menter ,2016). Menter (2016) identifies the relationship between theory and practice and the sites of professional learning among six enduring themes within teacher education, which require greater research. Recent policy changes in the UK have led to a greater use of 'school-led ' teacher education with pre-service teachers spending more time than ever in school settings and less time attending college based seminars. Philpott (2014) argues that at a time of increased debate regarding where teacher education takes place, ie. either in schools or on campus, it is more pressing to establish the 'how' of teacher education rather than the 'where'.

A key recommendation in Carter's (2015) review of teacher education in England is to commission a sector body to develop a framework of core content for initial teacher education. In his review he prescribes that pre-service teachers have the opportunity to:

- Observe good and outstanding teachers
- Understand the importance of observation and how to observe effectively
- Come together in peer groups
- Experience school as early as possible in the programme

Carter (P.21) further recommends that "effective programmes give careful consideration to how trainees' learning experiences are structured…… effective integration between different types of knowledge and skills trainees need to draw on in order to develop their own teaching and don't privilege 'theory' or 'practice' but integrate them in an environment where trainees have access to the practical wisdom of experts and can engage in a process of enquiry, in an environment where they are able to trial techniques and strategies and evaluate the outcomes."

Developments in Educational policy in the north and south of Ireland also challenge the current provision of initial teacher education. The development of partnerships between schools and universities is at the heart of the Irish Teaching Council's 'Guidelines on School Placement' (2013). The Irish Teaching Council calls for "new and innovative school placement models…using a partnership approach, whereby Higher Education Institutions and schools actively collaborate in the organisation of placement" (p.3). The recent introduction of a two-year Professional Master of Education degree as the only post-graduate route into teaching in the south of Ireland, also brings with it an extension of the proportion of time which pre-service teachers will spend in placement schools. This Council's placement model seeks to address some of the current issues within initial teacher education as identified in the Council's 'Policy on the Continuum of Teacher Education' (2011, P.8) such as "education must be reconceptualised so that it is fit-for-purpose in preparing 21st century teachers and interfaces appropriately with the induction stage," and "many current programmes are overloaded and are based on somewhat outdated models of provision where there is much emphasis on contact hours and assessment. This leaves insufficient time and space for the meaningful initiation of the development of teachers as reflective, enquiry-oriented, life-long learners." The Teaching Council's view of teacher education as a continuum requires that pre-service teachers are supported in developing the skills, habits and disposition for professional development and lifelong learning at the very early stages of their teacher education experiences. In the north of Ireland the importance of reflective practice is a fundamental premise of the General Teaching Councils' Competence Framework. Whilst the development of student teachers' reflective thinking is a key objective within all initial education programmes, Hagan (2013) proposes that here in Northern Ireland the emphasis on reflective practice is particularly strong. The General Teaching Council for Northern Ireland's publication 'Teaching: the Reflective Profession' (2007) states that "one of the principles which underpin the Council's concept of competence is the centrality of reflective practice.... (and that) competence is developed through reflection on practice and through dialogue with others," (p.13). The recent report on initial teacher education in Northern Ireland (Sahlberg et al., 2014, p.11) recognises the importance of school placement experiences where, "beginning teachers observe and analyse their own and other people's teaching, undertake progressively more demanding teaching episodes with learners, and begin to come to terms with the way of life of schools."

In summary an effective pedagogy for 21st century initial teacher education should;

- Provide opportunities for pre-service teachers to learn about teaching through teaching in a supportive, progressive and theory-rich environment.
- Forge stronger partnerships with schools in the joint exploration and creation of new forms of practice.
- Adopt collaborative forms of learning and conceptualise teacher education as a continuum.

Promoting enquiry-based science within ITE.

Reform of science education policies and the shift in curriculum towards more pupil-centred learning requires a change in classroom pedagogy. Qvortrup (2008) noted in the first Global Education Forum that the quality of teachers' training is the most important determinant of the quality of education and thus for the efficiency and quality of the pupils' learning. Osborne and Dillon's (2008) critical reflections on the state of science education in Europe recommended both a greater focus on extensive investigative work and hands-on experimentation, accompanied by high quality professional development for teachers.

Preparing pre-service teachers to plan, teach and evaluate their practice of enquiry-based science is particularly challenging. Firstly, there is no exact definition of enquiry and how it relates to the 'nature of science' (Lederman 2004) and no definitive list of science enquiry skills or types of enquiry (Millar, 2010). ITE tutors also need to consider the wide range of pre-service teachers' personal experiences and conceptualisations of science teaching, which may possibly be at odds to the methods and practices exemplified within their ITE programme. Prior experience and knowledge about teaching can "act as a filter or lens through which pre-service teachers take action" (Thomas & Pedersen, 2003, p.319). Encouragingly Luft's study

(2001) showed that teachers' beliefs and attitudes towards science enquiry can be more easily altered at the early stages of their careers.

Given that teachers' use of enquiry-based practices have been found to be influenced by their conceptions of science and the goals of education (Lotter et al, 2007), initial teacher education should aim to enculturate pre-service teachers into both the practice and the value of enquiry. A socio-cultural perspective on teaching and learning focuses on the role of language and discourse in learning. Lemke's (1990, p.16) suggestion that 'learning science is learning to talk science' highlights the role of the teacher in engaging pupils in exploratory and productive dialogue. This requires the teacher to have an understanding of enquiry and to possess "a functional language in order to help learners reflect" (Gyllenpalm et al 2010, p. 1154). This can best be achieved by blending on-campus discussions and the study of theory with first-hand classroom experience (Britner & Finson, 2005). Traditional school placement however may not be best suited to the ideal of "learning in and from practice" (Ball & Cohen, 1999). Santagata et al. (2007) challenge the two assumptions on which the typical model for school experience is based - that exposure to practice constitutes a learning experience; and that experience in the classroom 'melds' theory into practice. She proposes that the experience which pre-service teachers are exposed to may not represent best practice and may expose them to a limited repertoire of strategies used with an unrepresentative sample of pupils. Grossman and McDonald's (2008, p189) question why "university-based teacher educators leave the development of pedagogical skill in the interactive aspects of teaching almost entirely to field experiences, the component of professional education over which we have the least control." Blomberg et al (2014) caution that many pre-service teachers struggle to apply what they have learned in college to their actual practice and when faced with the 'practice shock' of the classroom they often revert to the intuitive theories of teaching and learning that correspond with their own experiences in school rather than with the research-based knowledge from their teacher program. However, a more fundamental problem with the idea of developing an ability to teach science through enquiry during placement through classroom teaching is the fact that opportunities to teach or observe teaching, can be limited (Blackmore et al, 2013).

The importance of classroom experience

As school placement is the cornerstone for initial teacher education programmes and school-centred models for ITE continue to be used, if students' experience of science during placement is quite limited then their own current and future science practice may also lack quality. A possible cycle of decline could therefore result as shown in Figure 1. A similar 'Catch-22' scenario relating to science education in Australia has been described by Kenny (2010), where in-service teachers lacking in confidence are less likely to model best practice for observing pre-service teachers let alone encourage or support them to teach science during their placements. Blackmore et al (2018) use Bronfenbrenner's (1979) bio-ecological model to trace how external factors such as government education policies and curriculum design contribute to the profile of science within primary schools and the future bearings on the development of pre-service teachers' professional identities. We feel that it is vitally important that initial teacher education institutions strive to break this potentially reductive cycle by providing on-campus learning activities and school-based experiences, which encourage and support pre-service teachers through their early attempts at teaching primary science.

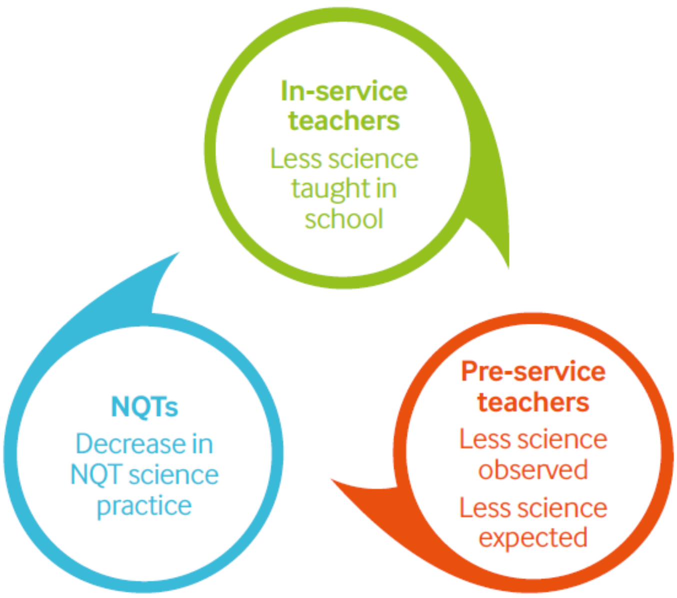


Figure 1: The potentially disastrous cycle of decline of primary science

Local context

In order to evidence pre-service teachers' experience of primary science during their annual school placement a survey was carried out of the entire Year 1 cohort at Stranmillis University College Belfast at the end of their first school placement in 2019. Consent to participate in the data collection activities, was obtained from all participants. A total of 53 participants (51%) completed a short questionnaire in which they recorded their experiences of science during placement and their confidence in teaching science. Figure 2.0 below shows that over a quarter of these student teachers did not teach science during placement and that just under a half of the group did not observe a science lesson.

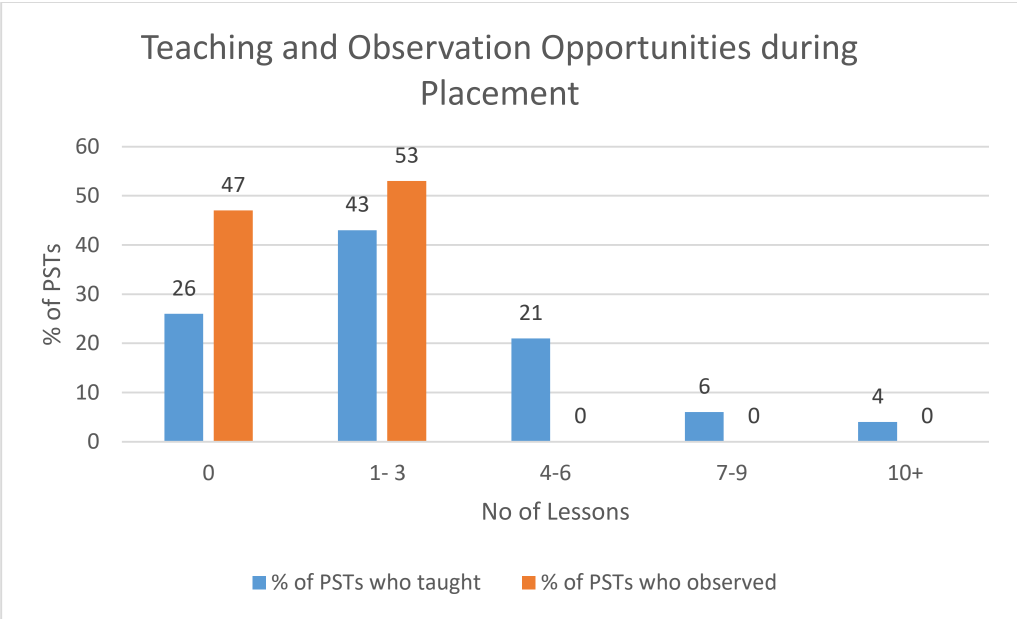


Figure 2: The science experiences during school placement of Year 1 pre-service teachers (N= 53)

The survey also found that;

- Two thirds agreed or strongly agreed with the statement 'I feel confident in my teaching of science'.
- One quarter agreed or strongly agreed with the statement 'I feel confident in my teaching of enquiry-based science'.
- 92% of participants reported that they would like to teach more science during future placements.

The data therefore indicates that the student teachers have a very limited experience of science during placement, a significant proportion do not feel confident in teaching enquiry-based science, but encouragingly, the majority are favourably disposed to teaching science in the future.

A recent survey (Lowry, 2017) of final year undergraduate student teachers within an ITE institution in Belfast found that student teachers lack experience and confidence in teaching primary science. Of the 66 students surveyed, 41% had taught less than 3 science lessons throughout the four years of their B.Ed degree and 11% of students had never taught any science. Direction from the host teacher and the students' own personal confidence featured highly among the factors they felt restricted their teaching of science during school placement. The most frequently cited means by which their confidence could be increased was:

- the opportunity to observe science lessons other than during placement (70%)
- the opportunity to teach science lessons other than during placement (55%)
- having more time within the ITE programme for primary science (60%).

Incorporating school experience within a bespoken science education module would allow for this.

Project Details

This project sought to enhance the current and future provision of hands- on enquiry-based science experiences for primary school pupils in Northern Ireland. The project aimed to do this by supporting all Year 1 and Year 2 students in their teaching of hands-on enquiry-based science lessons during their placement in a primary school. The students were required to provide lesson plans and an instructional video as a future teaching resource for their host teacher.

Project Outcomes

The project sought to develop the primary science provision of all participating schools by:

- Providing all participating teachers with the opportunity to observe and/ or co-teach hands-on science lessons with the support of Stranmillis University College tutors and student teachers.
- Provide all participating schools with lesson plans and instructional videos to support the professional development of teachers throughout the school.
- Develop the confidence and competence of approximately 228 student teachers in the area of enquiry-based primary science.

Project Timeline.

Planning and Preparation Phase

September- December 2021:

All Year 2 student teachers (122) attended 10 seminars and workshops on enquiry-based science. In compliance with the College's Covid-19 guidelines the series included some online seminars focusing on the theoretical aspects of enquiry-based science and six face-to-face workshops. The programme included aspects classroom practice, eg. planning, resource management, classroom management, assessment, evaluation, and also provided ideas and activities across each area of the primary science curriculum, eg light, sound, plants and animals, forces and motion, space etc. The workshops also supported the students in planning and resourcing the science lessons, which the students would be teaching in the spring term. The students had obtained information about their future science topics during a number of day visits to their school in the autumn term. The students also shared the project details with their host teachers during these visits. Unfortunately, due to Covid-19 restrictions the project could not include the planned demonstration lecture and workshop with RSC Outreach Officer Nick Barker. *(Nick's visit was rescheduled for Phase 3 of the project, at which stage the restrictions had been lifted.)*

January-February 2022:

All Year 1 student teachers (106) attended 4 seminars and workshops on enquiry-based science. In compliance with College's Covid-19 guidelines the series included some online seminars focusing on the theoretical aspects of enquiry-based science and face-to-face workshops. As this was the students' first experience of primary science within their ITE programme, the content included the role of science within the Northern Ireland Primary Curriculum and the importance of providing hands-on enquiry-based activities from Foundation Stage to Key Stage 2.

Teaching Phase for All

February-April 2022:

During the course of their seven-week placement in schools, all Year 1 and Year 2 students were required to teach a minimum of two science lessons to each of the two classes they were assigned to (during placement student teachers are required to teach two separate year groups, typically one at Foundation Stage/ Key Stage 1 and the other at Key Stage 2). All science lessons were firstly checked and approved by the host teacher. The host teacher was also invited to participate in the teaching of the lesson.

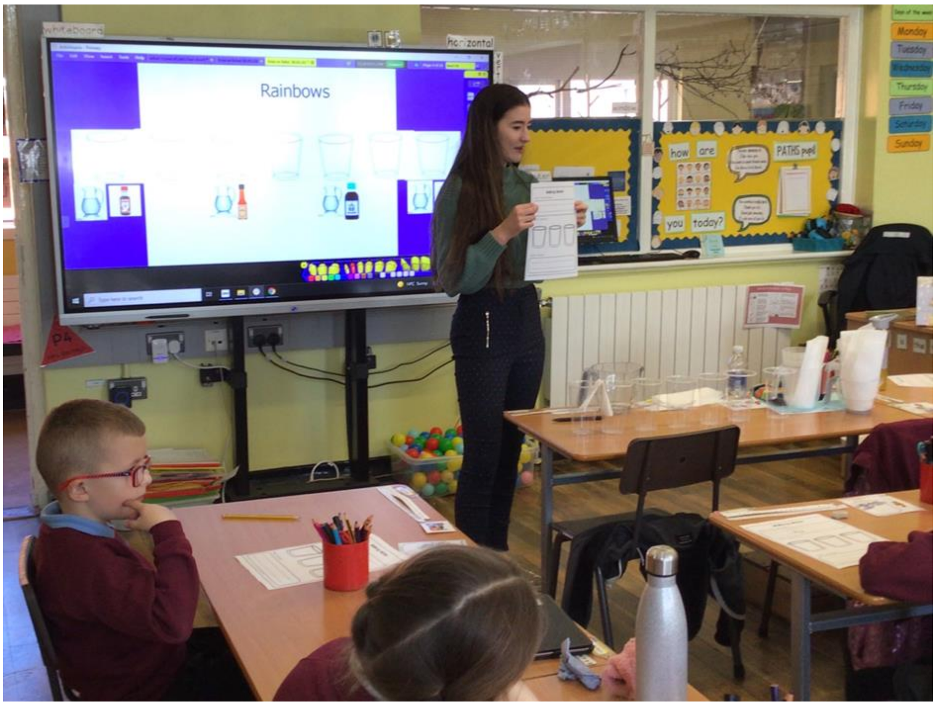


Figure 3: Student teacher explains the enquiry task.

Figure 4: Pupils carry out task, observe and record.

On completion of their science lessons, each pupil was presented with a science sticker (see Figure 5 below).

Figure 5: The sticker presented to all pupils on completion of their science lessons.

Examples of lesson plans and lesson evaluations for Key Stage 2 are shown in Appendix H and Key Stage 1 are shown in Appendix G.

Figure 6: Using iPads to investigate parachutes

Figure 7: Making Lava Lamps

Figure 8: Making natural flood barriers

Lesson 1: The Structure of a Volcano and Stages of a Volcanic Eruption

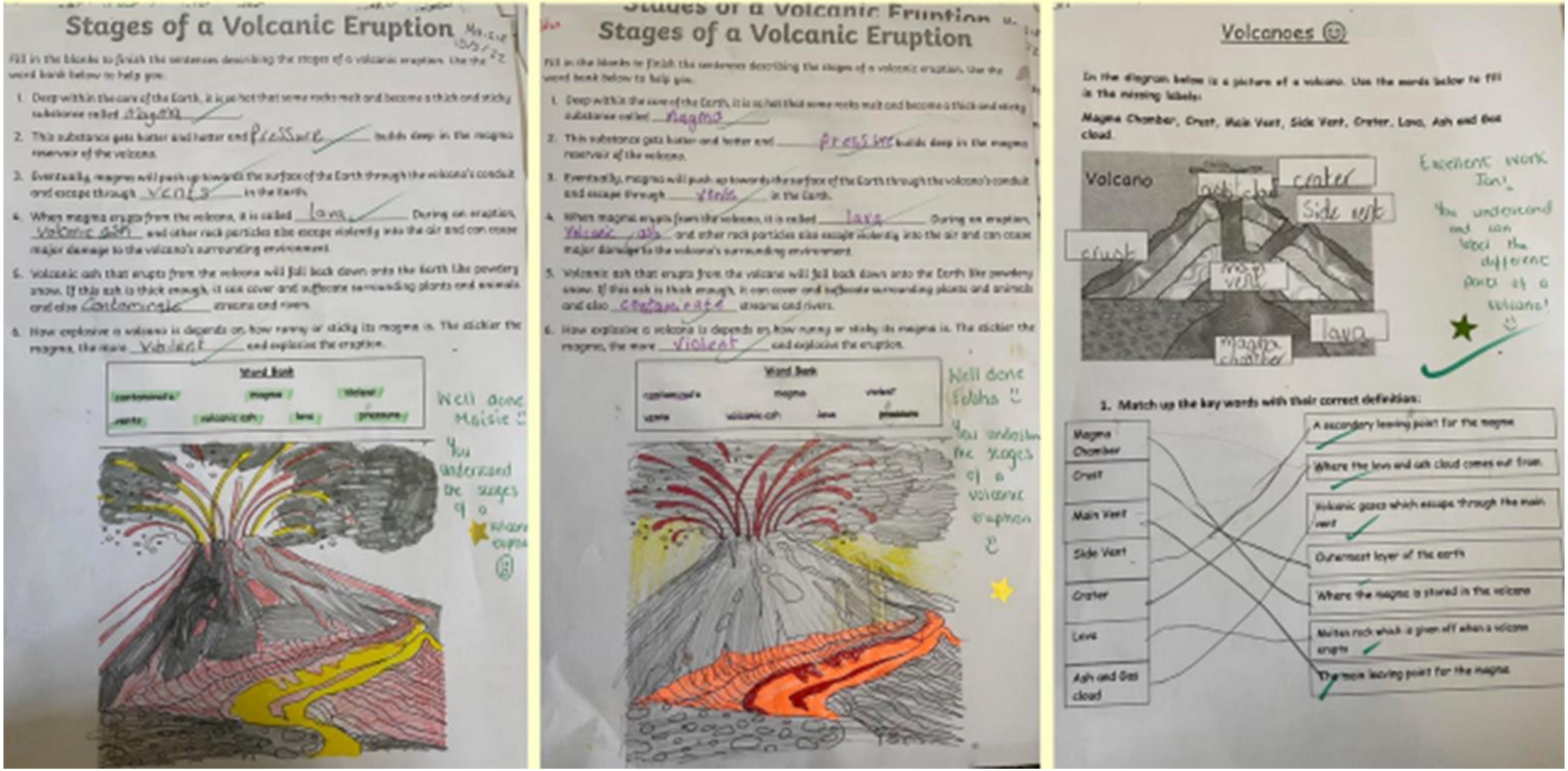


Figure 9: Sample of pupil's work

Celebration, Evaluation and Dissemination Phase
May-June 2022

During this phase the evaluation data was collected. These comprised questionnaires from student teachers and in-service teachers, lesson evaluation data, and classroom observation data. A number of students presented the lessons and shared their resources during the College's annual primary science conference on 18th May. The conference was attended by both year groups, and the wider College community. The keynote speaker at the conference was Nick Barker (RSC) who enthralled the students with an interactive and exciting display of chemical reactions and activities which they could include in their future practice. The conference poster is shown in Figure 10.

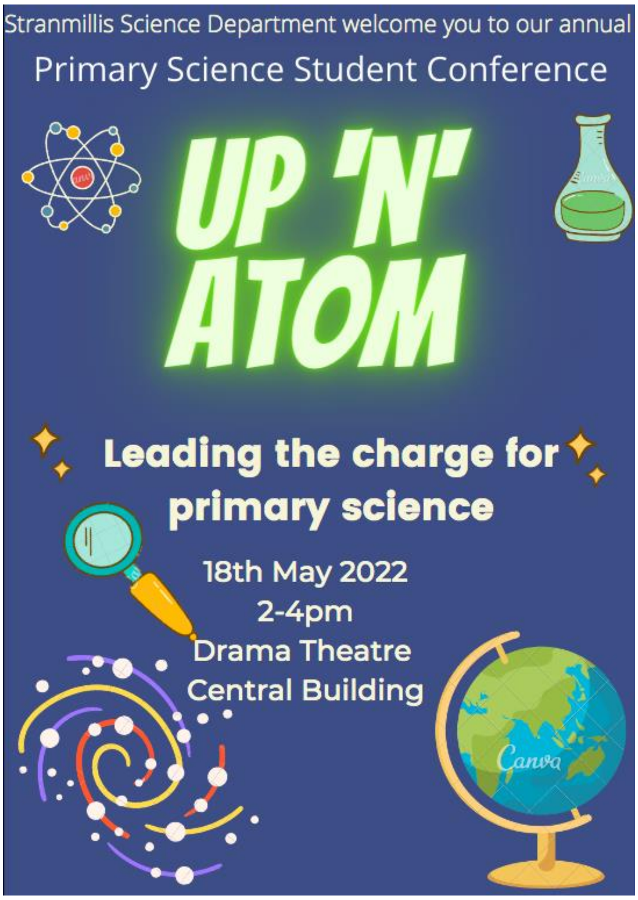
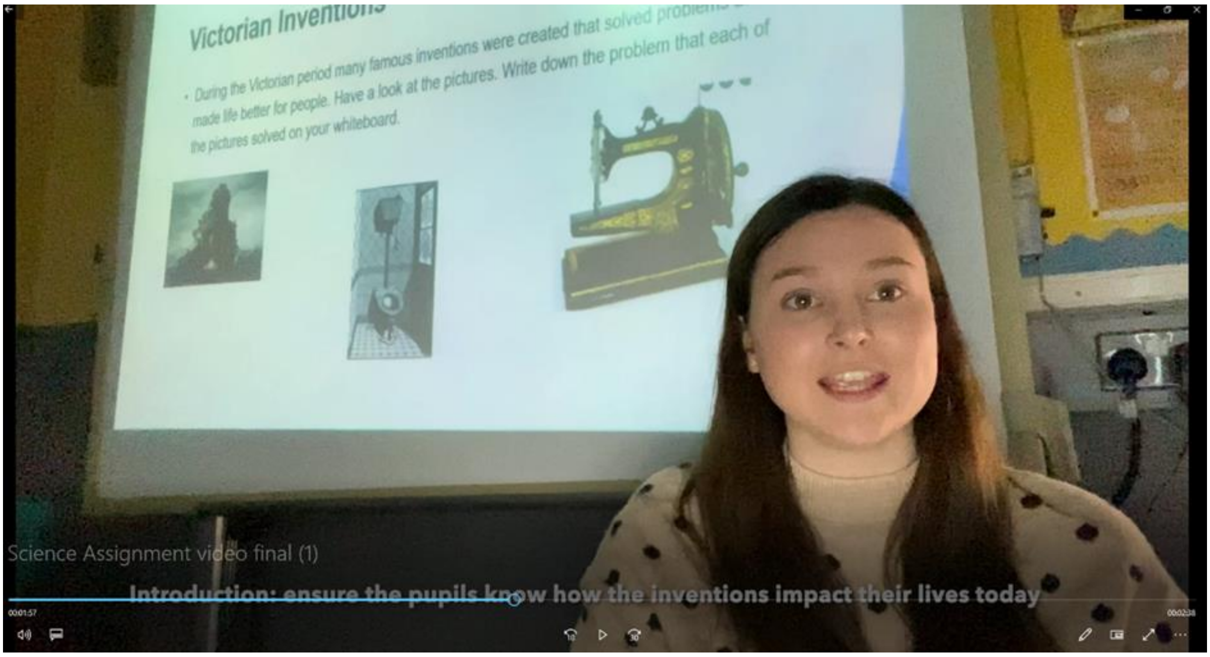


Figure 10: Poster for the Primary Science Student Conference.

Supporting Resources for Teachers

All students were required to produce the following resources and to share them with their class teacher at the end of their placement.

- Lesson plans for two of their lessons. All students used to Lesson Plan Template (See Appendix G and H)
- A short instructional video (5 minute maximum) describing the lessons.



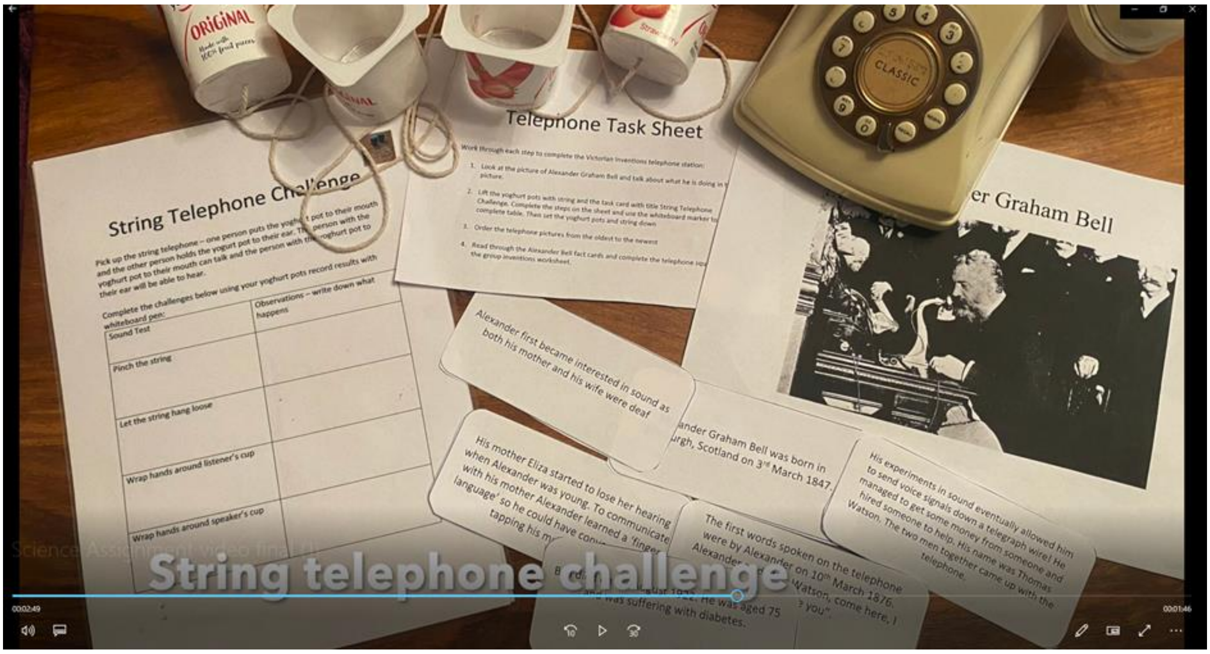


Figure 11 and 12: Images from a student's instructional video on teaching Victorian inventors.

Figure 13 and 14: Images from a student's instructional video on teaching about deforestation

The video is intended to serve as a resource to support another student teacher or an in-service teacher who is planning to teach these lessons and should be clearly presented in a professional manner.

Therefore:

- The recording should be made in a classroom or a teaching room and not an informal setting (unless the video relates to an activity carried out at home or in the kitchen and setting is a key aspect of the video).
- Image is steady and sound quality good.

The video should have clearly explained;

- How the lessons related to the topic, and to the Primary Science and technology curriculum.
- The science concepts, eg evaporation, wind resistance, components in an electrical circuit, healthy eating, or the enquiry skills that were developed eg. observation, recording, evaluating
- How the lesson developed and progressed.
- How the activity was managed, group sizes, resource management, your role throughout.
- How the key aspects of learning were drawn together in the plenary.
- Pupil reaction to the lesson. What did they enjoy, find challenging?
- Suggestions on follow –up lessons and activities or if the activity might be easily adapted to address other science topics, concepts or topics or develop other enquiry skills.

Project Evaluation

The evaluation of this project looked at its impact on each of the three parties involved; the student teachers, the in-service teachers and the pupils. The data collection and analysis methods adopted an interpretist paradigm and were guided by the following research questions:

1. Did the project increase student teachers' confidence and their ability to plan, teach and evaluate primary science lessons?
2. Did in-service teachers consider the project to be useful and would it support them to teach more science in the future?
3. Did the science lessons engage and interest the pupils?

The project evaluation plan and data collection protocols were all compliant with Stranmillis University Belfast's ethical code and approved by the College's Research Office.

Data Collection Methods

Given the large number of participants (228 student teachers, 228 in-service teachers, and pupils from 228 classrooms) the use of questionnaires was considered the most effective data collection method. For the Year 1 student teachers a baseline audit of their perceptions of primary science was carried out pre-project and then re-administered at the end of the academic year. The experiences of Year 2 students were captured by a single exit questionnaire. Questionnaires were also used to establish in-service teachers' practice and perceptions of primary science before the project and at the end to determine if they had found it to be useful. The impact of the enquiry-based science lessons on the pupils was measured using a structured observation activity using a modified version of Walsh's Quality Learning Instrument (Walsh & Gardner, 2005). We have used this enquiry-based science Quality Learning Instrument (QLI-ebs) in previous studies to determine how pupils react to enquiry-based approaches to teaching science (Muphy, et al, 2013). The project involved all 209 schools who had agreed to provide a placement for either a Year 1 or Year 2 student teacher (Appendix F).

Project Findings

The evaluation data will address each of the three research questions in turn:

1. Did the project increase student teachers' confidence and their ability to plan, teach and evaluate primary science lessons?
2. Did in-service teachers consider the project to be useful and would it support them to teach more science in the future?
3. Did the science lessons engage and interest the pupils?

Research Question 1:

Year 1 students

Data was collected from Year 1 students both prior to and after the project. A confidence audit (Appendix A and B) that explored a number of areas relating to their teaching (eg. their confidence across a range of teaching competences, their perceptions of science) was distributed before and after school placement.

The pre-project confidence audit had a return of 61.3%, with 65 students responding from a sample size of 106. The post-project audit had a return of 54.7%, with 58 students responding.

When comparing the pre and post-project data, it was evident that student confidence in all teaching competences increased. The competences, adapted from General Teaching Council of Northern Ireland (2011), cover aspects of planning, teaching and evaluating classroom practice (see Figure 15):

Aspect of Practice	Teacher Competence
Planning	Display knowledge and understanding of science
	Set appropriate learning outcomes
	Plan lessons that enable all learners (including those with special and additional needs) to meet the learning intentions.
Teaching	Guide the work of other adults to support pupil learning
	Create and maintain a safe, interactive and challenging learning environment
	Use a range of teaching strategies and resources, including eLearning where appropriate
Evaluation	Evaluates lessons/ activities
	Monitoring learner progress
	Use a range of assessment strategies to evaluate learning
	Evaluate lessons taught and use critical reflection to guide future planning.

Figure 15: Overview of Teacher Competences

Students had to rate their confidence in each competence on a scale of 1-4, with 4 being 'very confident' and 1 being 'not confident'. Pre-project, students responded with the majority of students being either 'confident' or 'quite confident' in all teaching competences. Notably, post-project, the majority of students were either 'very confident' or 'confident' in all competences, and encouragingly, no students were 'not confident' in any aspect.

	PRE-PROJECT				POST-PROJECT			
	4	3	2	1	4	3	2	1
Display knowledge and understanding of science	5	39	21	0	10	44	4	0
Set appropriate learning outcomes	1	35	28	1	20	33	5	0
Plan lessons/ activities that enable all learners (including those with special and additional needs) to meet learning intentions	4	34	23	4	22	32	4	0
Evaluate lessons/ activities	6	35	24	0	22	35	1	0
Guide the work of other adults to support pupil learning	4	32	25	4	15	33	10	0
Create and maintain a safe, interactive and challenging learning environment	12	42	10	1	26	31	1	0
Use a range of teaching strategies and resources, including eLearning where appropriate	5	43	17	0	24	31	3	0
Monitoring learner progress	4	42	18	1	23	30	5	0
Use a range of assessment strategies to evaluate learning	3	37	23	2	17	33	8	0
Evaluate lessons taught and use critical reflection to guide future planning	5	29	29	2	23	30	5	0

Figure 16: Student responses regarding their confidence in teacher competences

A scoring procedure enabled the researchers to rank competences in order of student confidence (see Figure 16). Interestingly, students remained most confident in the same two competences, which focus on actual teaching aspects. Students remained most confident in creating an effective learning environment, and in using relevant and appropriate teaching strategies and resources. According to ETI (2015) teachers noted not doing science in the primary school because they lacked resources. This project used funding to supply resources to each school and evidently supported and facilitated student teacher confidence in delivering science lessons.

	Pre-Project	Post-project
1	Create and maintain a safe, interactive and challenging learning environment	Create and maintain a safe, interactive and challenging learning environment
2	Use a range of teaching strategies and resources, including eLearning where appropriate	Use a range of teaching strategies and resources, including eLearning where appropriate
3	Display knowledge and understanding of science Monitoring learner progress	Evaluate lessons/ activities
4		Monitoring learner progress Evaluate lessons taught and use critical reflection to guide future planning Plan lessons/ activities that enable all learners (including those with special and additional needs) to meet learning intentions
5	Evaluate lessons/ activities	
6	Use a range of assessment strategies to evaluate learning	
7	Plan lessons/ activities that enable all learners (including those with special and additional needs) to meet learning intentions	Set appropriate learning outcomes
8	Evaluate lessons taught and use critical reflection to guide future planning.	Use a range of assessment strategies to evaluate learning
9	Guide the work of other adults to support pupil learning	Display knowledge and understanding of science
10	Set appropriate learning outcomes	Guide the work of other adults to support pupil learning

Figure 17: Ranking student confidence in teacher competences

Of more interest, in Figure 17, is the rank position of 'Display knowledge and understanding of science' post-project. Whilst confidence in this teacher competence developed overall, it's rank position dropped from 3rd position to 9th following the project. Interestingly, students noted, qualitatively, that the project made them realise the need to fully understand the science concepts before teaching:

"It's given me the knowledge that pupils have a great interest in science and that it's very important to know the topic that you're teaching, very well." (Student 35).

"I have had to re-learn parts of science to be able to teach it." (Student 36)

The development of their science knowledge and understanding was a future support need identified by students.

When the pre and post project data was compared, the % change in each aspect of practice was calculated, with the highest level of development noted in the evaluation and planning aspects of the students' practice (Figure 18). This demonstrated a difference from the ranking analysis where practice remained at the top.

1	Evaluate lessons taught and use critical reflection to guide future planning.	+39%
2	Set appropriate learning outcomes	+36%
3	Evaluate lessons/ activities	+35.2%
4	Plan lessons/ activities that enable all learners (including those with special and additional needs) to meet learning intentions	+34.6%
5	Monitoring learner progress Use a range of teaching strategies and resources, including eLearning where appropriate	+33.5%
7	Guide the work of other adults to support pupil learning	+27.3%
8	Create and maintain a safe, interactive and challenging learning environment	+26.3%
9	Display knowledge and understanding of science	+25.4%
10	Use a range of assessment strategies to evaluate learning	+24.7%

Figure 18: The % change in confidence levels

On average, evaluation aspects development was +33.1%, compared to +32% in planning and +29% in teaching competences. To conclude, the project not only developed students' practice but also enhanced their ability to plan, and their ability to reflect and evaluate what they had taught and how.

Student teachers' perceptions of science were also explored in the confidence audit. It was evident that the project extended their appreciation of science in the primary classroom, as they described it as 'crucial', 'essential' and 'vital' for children's development of invaluable life skills, and for giving children opportunities to learn about the world around them. Students described science as very important also, due to the fact that children enjoy it and that it acts as a stepping-stone towards post-primary science. Other reasons noted by students as to why science is very important include the opportunities it provides for hands-on learning, the conceptual understanding that results, the inclusive, cross-curricular nature of science, and the creativity that children can develop in science lessons.

In terms of student teacher gains from the project overall, students noted that the project was valuable as it actually made them teach science in the classroom. They claimed they now recognise the need to have science in the primary school, are much more aware of its value, and have recorded that they are motivated to teach even more science:

> "*Prior to teaching the lessons, I didn't think Science should be high priority however after teaching it and seeing the benefits first hand I feel it is extremely important." (Student 5)*

> *"Before placement, I would have been scared to teach science as I don't have much experience from my time in primary school. However, after seeing how well the children responded to the topic I will teach it more in the future." (Student 11)*

> *"I will be teaching more science in future as I saw first hand how fundamental this is to overall pupil development." (Student 3)*

They noted a change in their attitude also, now being happy to teach science rather than being 'scared of it'. They also identified the importance of teaching science in the earliest years of schooling:

> *"It has helped me to learn the scientific theory before I teach it to children. It has shown me the importance of teaching science to children when they are younger when they absorb information even better." (Student 40)*

Interestingly, students also noted the development of their science knowledge also, despite their confidence in this knowledge not progressing as fully as other competences:

“At first I was apprehensive to teach science as I felt my experience in secondary school negatively impacted my attitude in science. Although, during my time in SBW, I built confidence and progressed with my own science learning alongside the pupils.” (Student 31)

“This project has influenced by understanding and teaching by enabling me to gain knowledge and understanding and has made teaching science more approachable and less scary.” (Student 58)

Students noted the development of their own creativity having taught science in the primary classroom:

“*This project has helped me to step outside the box and think of creative ways to teach science. It has taught me the importance of students’ active involvement in science to generate an interest in the subject.” (Student 18)*

They claimed that they were now aware of how simple science can be, and had developed strategies to help break down difficult science concepts:

“It has let me see that primary science does not have to be overly complicated lessons but it can be simple and this can be even more effective.” (Student 52)

Students stated that their awareness of useful resources and websites was enhanced by participating in the project, and they had ease of access to resources. Again students noted that pupils loved science and this influenced their outlook on science teaching and learning, as they wanted to inspire pupils to become even more passionate about science.

Beyond science teaching and learning students identified other aspects of their professional development that were enhanced following their participation in the project. Student teachers’ confidence in front of the room was mentioned most frequently as having developed, followed by a development in their ability to manage practical activities. They also developed their ability to manage various groups at once, to manage class behaviour, and to manage learning more effectively also:

“This project taught me how to teach children whilst they are very unsettled and control them at the same time.” (Student 11)

"It has developed my ability to control various groups of children who are completing different tasks, ensuring they are receiving equal attention and support." (Student 14)

"My ability to control a large class whilst completing an experiment was developed. I was challenged to keep them all engaged and ensure learning was maximized." (Student 39)

Additionally, their communication skills were developed, particularly their ability to give clear instructions. Time management, organization, and problem-solving skills too were noted as important outcomes for the students from the project. Some students noted how they developed in extending their future practice through reflecting on their practice:

"I have been able to develop my science lessons by looking at my mistakes and evaluation." (Student 53)

"The ability to evaluate lessons and use critical reflection to improve future lessons." (Student 54)

In terms of their requests for future support students highlighted two key needs; more lesson ideas for teaching topics and more access to resources. Other support needs noted were differentiation strategies to support the delivery of science to all learners, and more time teaching science in schools.

Year 2 Student teachers

Data was obtained from questionnaires administered after the teaching phase of the project (see Appendix C). While 122 Year 2 students took part in the project, questionnaires were returned by 106 (N=106, 87%)

Almost all students (96%) felt that the project had developed their ability to teach primary science, with only 1% feeling it hadn't and 3% 'unsure'. The impact on students is shown in Figures 19-22 below which consider four aspects of initial science teacher education.

The impact on students' classroom practice is shown in Figure 19. All three elements of practice are considered to have been developed. Classroom management was the aspect of practice which the greatest proportion of students reported an increase in. Given that the managing of classroom activities and resources is probably the area of practice which student teachers find the most difficult, this is quite significant and evidences the value in ensuring science ITE provides opportunities for students to teach in schools. The fact that the project required pupils to teach hands-on practical activities, rather than rely on worksheets and more didactic teacher-led approaches was also cited as important.

> *" I feel that science lessons need even greater organisation than other lessons and so the practice I got of managing a classroom with many resources helped develop my ability to explain and teach clearly." (Student 11)*

Students also reported development in their planning and evaluating skills.

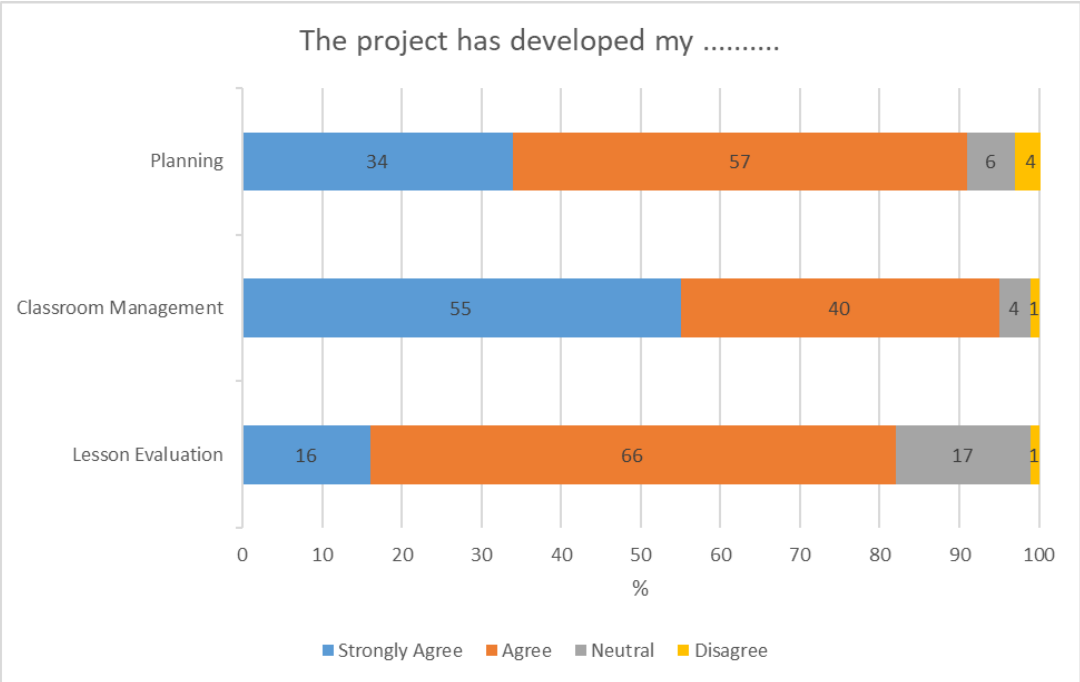


Figure 19: Impact of project on student teachers' classroom practice

The project was considered by students to also have significant impact on their understanding of science subject knowledge and their ability to connect scientific phenomena and ideas to the topics commonly studied in the primary curriculum's Area of Learning, 'The World Around Us.' The project also brought about a increase in students' appreciation of the benefits of teaching science in the primary school (Figure 20).

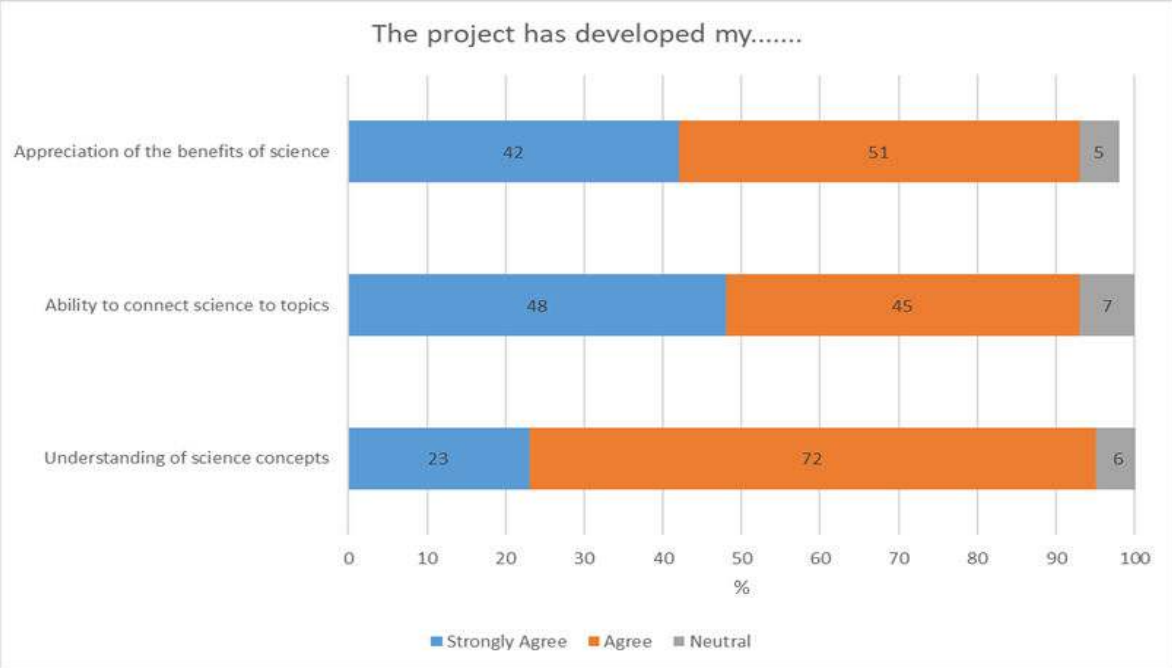


Figure 20: Impact of project on student teachers' subject and curriculum knowledge

The project also changed how the student teachers felt about teaching science in the primary school. Figure 21 evidences their increase in confidence and more positive disposition to teaching science in the future.

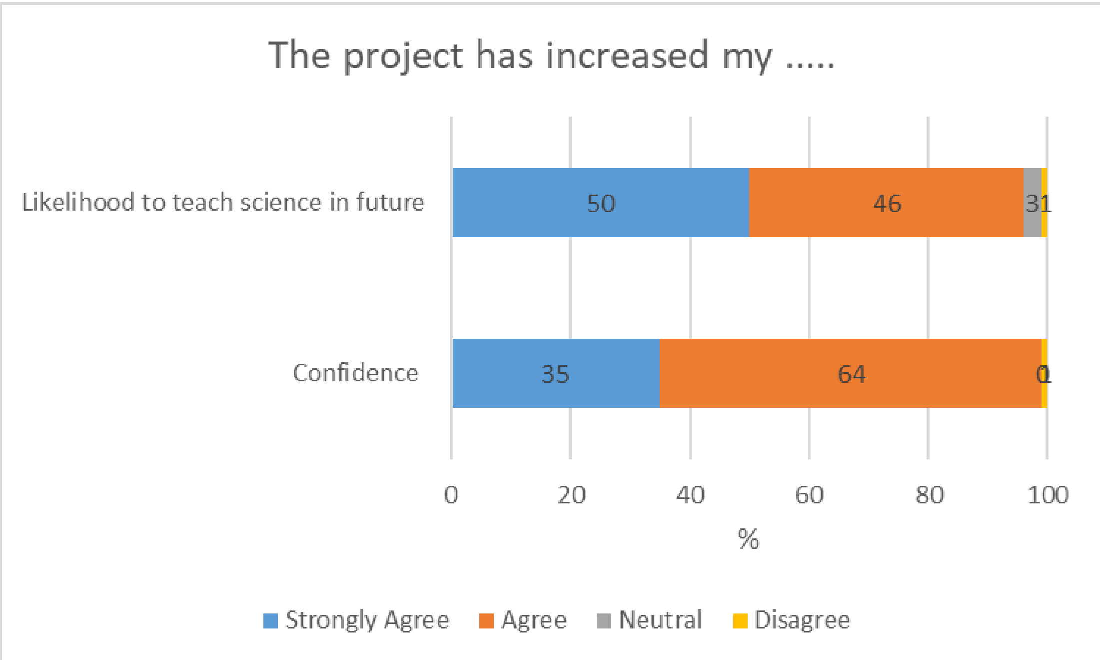


Figure 21: Impact of project on student teachers' disposition to teaching science

The project also enabled the students to learn more from the school placement phase of their ITE programme. The data (Figure 22) suggests they felt a greater sense of professional agency during their time in school and were able to align the advice and guidance from their host teacher with aspects of theory covered earlier in the academic year on campus.

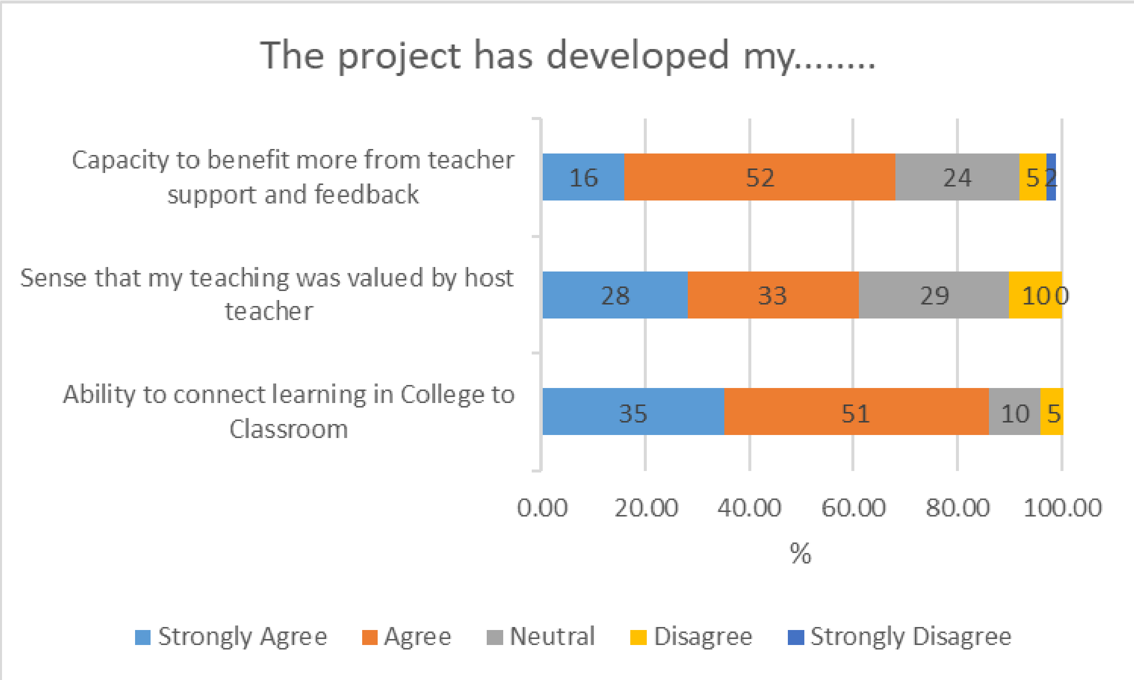


Figure 22: Impact of project on student teachers' capacity to learn within the ITE programme.

Most Beneficial Aspects of the Project

The most frequently cited feature was that the project required all the students to actually teach science during their placement (cited by 19% of all respondents). It was from this experience that students reported an increase in their confidence.

> *"By forcing myself to teach lessons my confidence in teaching science improved" (Student 17)*

> *"Being forced out of my comfort zone was very beneficial as it made me more likely to to teach science and I now have a greater appreciation for the benefits science lessons and activities have on the pupils."(Student 28)*

This first-hand experience of teaching allowed the students to directly observe how pupils reacted to the lessons. The experience of putting into practice their lessons not only provided students with the opportunity to enact their plans but provided them with an up close view of how pupils reacted:

> *"The most valuable part was putting into practice what I had learned in College. This was very beneficial, seeing pupils reaction." (Student 23)*
>
> *" I was able to see how much pupils actually enjoyed participating in science lessons and it has been amazing to see how well pupils were able to grasp science concepts and apply them to the activities. Therefore, I felt more confident in teaching science as I saw how well pupils reacted to it. (Student 9)*

Other frequently cited strengths of the project were:

- The high level of support from tutors during the planning phase
- Direct and easy access to a wide range of disposable resources and materials (eg cooking oil, food dye, balloons, bicarbonate of soda.)
- The classroom observation tasks using the QLI protocol provided students with an effective and valuable lesson evaluation tool.
- The year-long timeline of the project encouraged students to forge connections between campus-based work-shops and seminars held during semester 1 and their classroom teaching in semester 2.

Research Question 2:

Teachers' practice and views pre-project

A total of 48 (21%) questionnaires (Appendix D) were returned from the 228 teachers who participated in the project. The questionnaire explored teachers' current practice of science and their views on issues relating to their teaching of primary science.

Science teaching time

Over three quarters of the teachers who responded teach a maximum of 30 minutes of science per week (Figure 23). In a primary school this could represent no more than one lesson. On a positive outlook, there is an appetite for science as 91% felt that there should be more science in the primary curriculum.

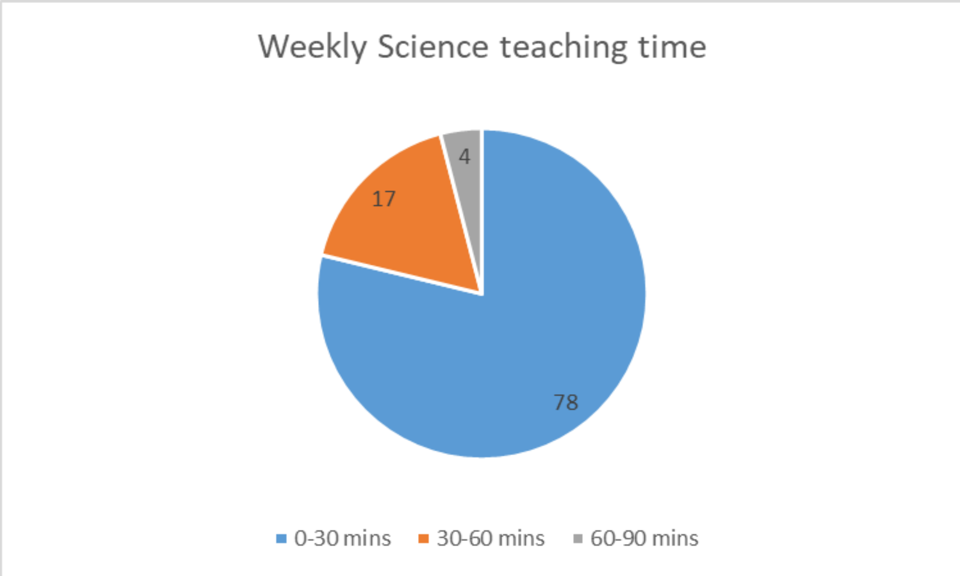


Figure 23: The amount of weekly teaching time for science.

The factors which teachers identified as limiting or restricting the amount of science they teach are shown in Figure 24. The biggest barrier to teaching science appears to be the amount of time available for science within the primary school curriculum.

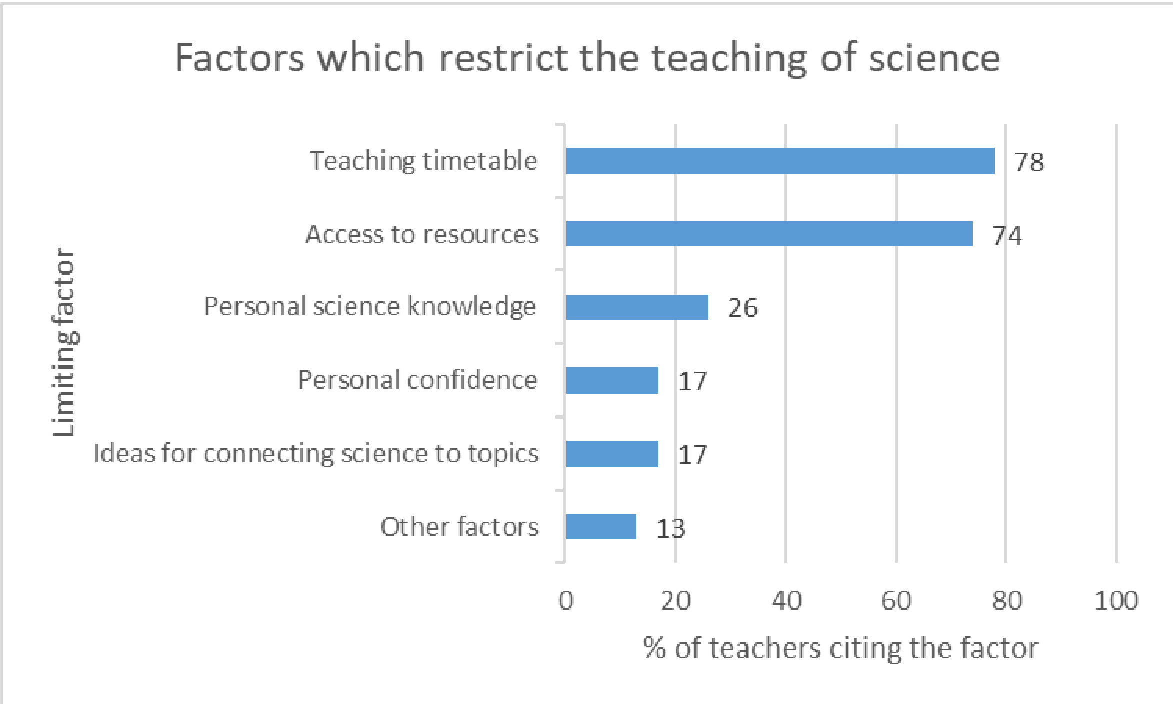


Figure 24: Teachers' views on what limits their teaching of science.

A number of teachers developed this point in their open-ended responses:

> *"Science has been forgotten. It was always fun!" (Teacher 23)*
>
> *"Science has become watered down." (Teacher 9)*
>
> *"Science has been abandoned!" (Teacher 17)*
>
> *"Science needs to be a discreet subject." (Teacher 11)*

Encouragingly many teachers were positive about teaching science. The availability of resources was also a common issue:

> *"I love teaching science!" (Teacher 5)*
>
> *"I would love to teach more but time constraints and lack of equipment are an issue." (Teacher 7)*
>
> *"The children in my class and in every class I have ever taught love to be involved in science lessons and are always enthusiastic and engaged. Time is our biggest constraint and we often have to 'resource' a lesson ourselves as materials are not always available in school." (Teacher 12)*
>
> *"I would love to teach more but time constraints and lack of equipment are an issue." (Teacher 14)*
>
> *"Schools need more money for practical-based subjects." (Teacher 23)*

What would best support teachers to teach more science?

The provision of resources was most frequently cited as a factor, which would support teachers to teach more science (Figure 25).

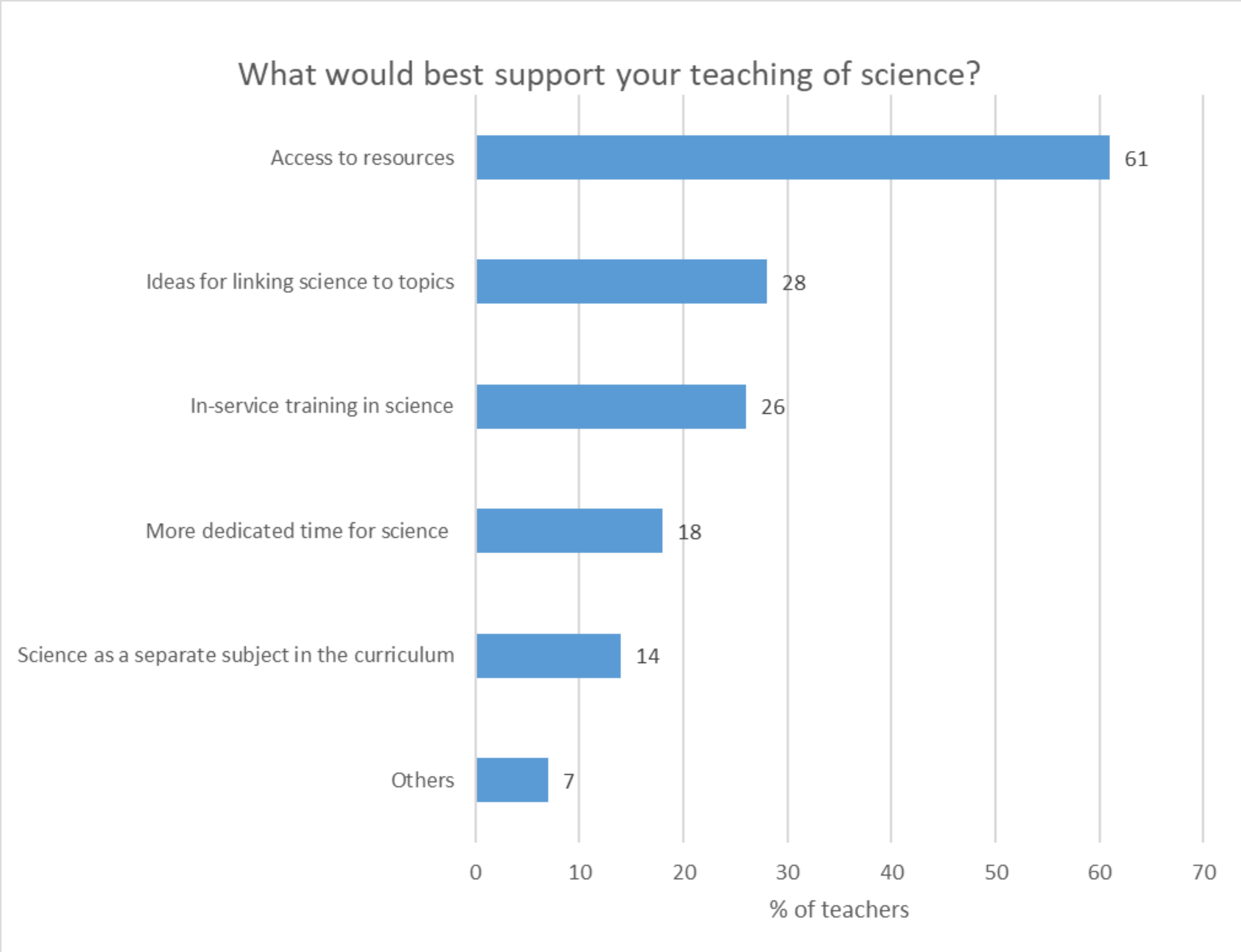


Figure 25: What teachers consider would best support their teaching of science.

There was also strong support for more training, particularly on how to integrate science into topics (examples of popular topics are 'Spring', 'World War 2', 'The Egyptians', 'Houses and Homes.'). The factors reported as 'others' include, more science-related out-of-school trips, more adults to help out during practical work, and the option to team teach.

Teachers' practice and views post-project

Feedback from the teachers at the end of the project was very positive. A total of 53 questionnaires (Appendix E) were returned (23%) of which 93% reported that the project had been useful (Figure 26).

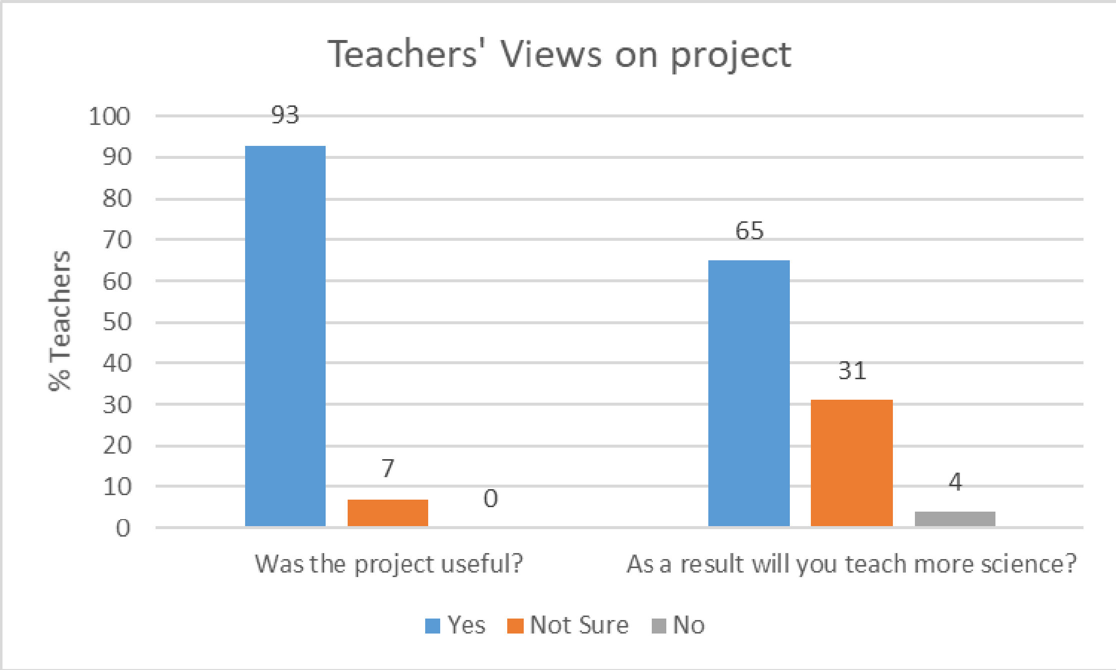


Figure 26: Teachers' views on the project.

Useful aspects of the project

From the analysis of the teachers' explanations of why the project was useful the following themes emerged.

- The project provided teachers with the opportunity to directly observe that pupils were highly engaged and really enjoyed the science lessons and so encouraged them to teach more science in future.
- Teachers could see that science lessons can involve ordinary everyday materials and do not have to require specialist equipment or resources.
- The project provided access to high quality resources.
- Having taken part and/or observed the science lessons the teachers felt very ready to adopt them into their future schemes of work.
- The project provided a wide range of ideas and teaching approaches within the chosen topics.
- The project provided a great experience for the pupils.
- A specific aim of the project was that student teachers would produce lesson plans and an instructional video to support the teacher and the school in the future.
- The project increased the profile of science across the school.

Impact on future teaching

Just under two thirds of the teachers expressed the view that as a result of the project they would teach more science in the future (Figure 26). Thematic analysis of the teachers' explanations revealed the following themes.

- The lessons related to the classes science topic, so the planning and resourcing were all relevant to year group and guided by the classroom set-up, the abilities of the pupils and professional needs of the particular teacher.
- The benefits of teaching science could be directly observed by the teacher. This in turn encouraged teachers to seek opportunities to include more science in their future lessons.
- The enquiry-based approach allowed teachers to see the potential for skills development, including transferable skills such as communicating, problem solving, working as a group and decision making.
- The pupils' high level of enjoyment and engagement highlighted the importance of providing hands-on activities when teaching.

Research Question 3:

The impact of the project on pupils' interest in learning science and their engagement with the lessons was determined by the classroom observations made by the student teachers. The Year 1 students, in line with their stage of development in ITE, completed general observations of pupil engagement. In comparison, however, Year 2 students used the enquiry-based science Quality Learning Instrument (QLI-ebs) to structure and develop their evaluation of pupil engagement. This required the student teacher to assess the overall level of pupil behaviours as either High, Medium or Low, with respect to motivation, confidence, observation and communication, predicting, problem-solving and decision making. The QLI-ebs) also requires the students to support their rating by adding comment on each area. (A sample of a completed QLI-ebs is included in Appendix D and E). Almost all (96%) (See Figure 27) of the students rated the level of pupil motivation as 'high'. This is consistent with the feedback from the student teachers and the in-service teachers on how pupils reacted to and during the science lessons. The % of students rating pupil confidence as 'high' of pupil confidence is lower (36%) and may reflect the fact that pupils have limited prior experience of doing hands-on activities in primary science, as evidenced by the data relating to the teachers' current practice in science and the student teachers' general feedback. The variation in the proportion of lessons rated as high with respect to the four enquiry skills (observing and communicating, predicting, problem-solving and decision making) reflects the fact that the wide range of enquiry-based lessons did not target each skill to the same extent. The data does show that even over the course of a short series of lessons pupils were having the opportunity to develop a wide range of enquiry skills.

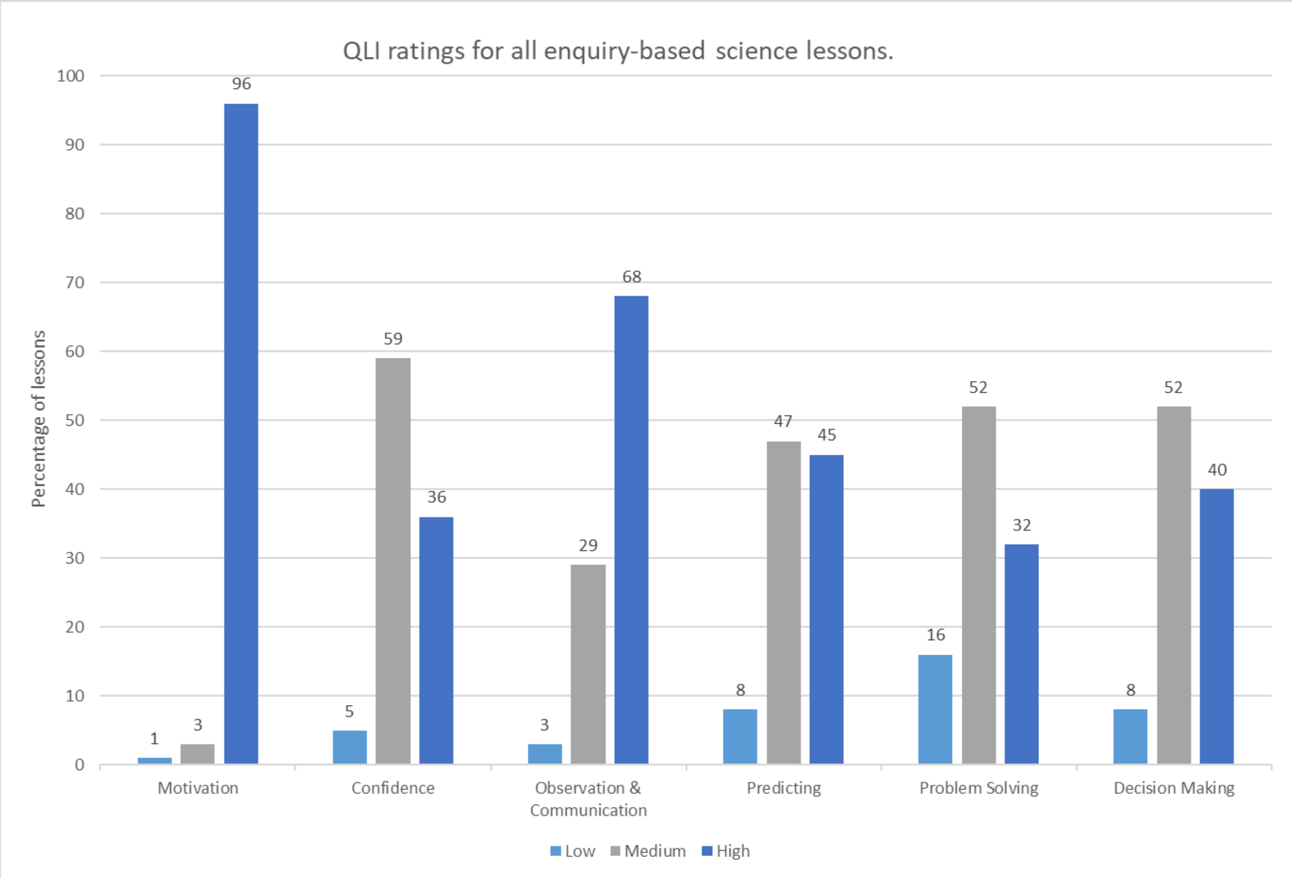


Figure 27: The QLI-ebs data based as recorded by Year 2 students.

Examples of student feedback:

Pupils’ confidence rated High for a Year 5 lesson on ‘water proofing’.

“The children’s motivation across the two lessons was at a high level as they were conducting investigations with their peers. The engaging story told during the waterproof investigation helped to heighten their motivation and engaged them thoroughly in what was expected from them. The picture of the dirty oven and then how it was cleaned using a chemical reaction certainly helped with the engagement and enthusiasm of the second lesson on volcanic eruptions. For both investigations, the children could not wait to get started and talking about the experiments clearly indicated this. The enthusiasm shown during both lessons was at an exceptionally high level and all children thoroughly engaged throughout. Using AFL at the end of both lessons demonstrated the enjoyment which the children experienced during both lessons. “

Pupils’ demonstrating high levels of observation and communication during a Year 6 lesson on ‘Victorian inventions.’

“Observation of children’s discussion and communication skills were insightful as all groups maintained focused conversations assisting each other to complete the tasks. Pupils observed various inventions and one pupil even described the change in camera technology as amazingly quick in the last few years. The expanding key vocabulary was used by the pupils throughout the lesson.”

Pupils’ predicting skills rated as medium during a Year 2 and 3 composite class lesson on ‘teeth’.

“Everyone was able to make and record their predictions, however for some pupils these were very simple. One pupil had put the same prediction down for each, after discussing with him I found it was because he didn’t know what could happen and didn’t want to be wrong. We did a lot of talking about how it was okay to predict incorrectly, they weren’t supposed to always get it right, otherwise why would we bother doing the experiment if they could tell us the results anyway.”

The students also provided feedback on the overall level of pupils' engagement with the science lessons. All students reported that pupils were very enthusiastic and excited to do science.

Comments based on a Year 4 lesson on 'Ancient Egypt.'

I found that the children were very motivated to take part in my science lessons and were eager to begin. Through my time on placement, I noticed that science did not feature on the timetable in a usual week and pupils didn't have much opportunity to complete science lessons. Therefore, when pupils learnt that they would be doing two science lessons that week, they were motivated to take part. Furthermore, children thoroughly enjoyed exploring the topic of the ancient Egyptians and were excited to explore this further through the medium of science. Pupils enjoyed the opportunity to explore the purpose of a shaduf and to gain an understanding of why they were used by the ancient Egyptians. I observed that pupils were motivated when they learned that they would be taking part in a practical activity of constructing a model shaduf as this was not something that they had the opportunity to take part in very often in school. Finally, another aspect that helped to motivate pupils was when they learnt that this was a competition between groups. Despite being enthusiastic to begin the two science lessons, pupils lack of opportunity to take part in science lessons led to some children being nervous and unsure before beginning these lessons. However, I found that this lack of confidence was only an initial worry and pupils were quick to overcome this when I clearly explained what they would be learning and the activities they would be completing. By introducing and explaining the different materials in the first lesson and giving pupils the task of creating a diagram of their proposed shaduf I found that this helped pupils to become more confident in their approach to creating their model in the next lesson. As pupils had discussed in their group what materials they would like to use and why, this allowed pupils to grow in confidence when it came to actually creating their model. By setting up a testing area for pupils to use when creating their model, they were able to observe the functionality of it and thus determine if changes in deign were necessary. Through this testing area, pupils became confident to present their final model at the end of the lesson and to take part in the competition.

Celebration and Dissemination

The College's annual primary science conference (See Figure 28 and 29) was used to enable the student teachers to share their work with their peers and tutors. The conference also featured an exciting demonstration lecture from the RSC Outreach Officer Nick Barker. Nick's lecture demonstrated a range of exciting demonstrations and hands-on activities which the students could incorporate into their future teaching. Nick's presentation also included his experiences of delivering science outreach across the UK and why primary science matters in the primary school. Nick's visit provided further motivation for the student teachers to continue to develop their practice as evidenced by comments made by students after the conference.

Nick's lecture was inspiring. I'm definitely going to try some of those activities out with my next class.

It was really interesting to hear about his work promoting primary science in schools in England.

Figures 28 & 29: Nick Barker's (RSC) demonstration lecture.

Figure 30: Students sharing their work at the Primary Science Conference.

Conclusions and Recommendations

This project sought to enhance the current and future provision of hands- on enquiry-based science experiences for primary school pupils in Northern Ireland. The findings indicate that pupil engagement and attainment was high, student teachers feel much more competent and confident in teaching science and that in-service teachers found the project useful and as a result will be more positively disposed to teaching science in the future.

Project Outcomes

The findings evidence that all the project outcomes where met. The project ……

- Provided all participating teachers with the opportunity to observe and/ or co-teach hands-on science lessons with the support of Stranmillis University College tutors and student teachers. The data indicates that the participating teachers found that experiencing and participating in the science lessons provided them with ideas and teaching strategies, which they could use in their future teaching.
- Provided all participating schools with lesson plans and instructional videos to support the professional development of teachers throughout the school. All participating teachers were provided with these resources. Some teachers shared these resources with their colleagues.
- Developed the confidence and competence of 228 student teachers in the area of enquiry-based primary science. Both cohorts of student teachers reported increases in all areas of classroom practice and their subject, curricular and pedagogical knowledge.

Project Impact

Student teachers:

- Increase their confidence in teaching primary science
- Became more likely to teach science in future practice.

- Valued the opportunity to teach science in schools.
- Valued having access to resources

Pupils:

- Enjoyed learning science, particularly the hands-on activities.
- Developed enquiry skills and personal skills and capabilities.
- Developed understanding of science concepts and phenomena.

Teachers:

- Found the project useful and as a result will be more inclined to teach science
- Developed their appreciation of the value of science within the primary curriculum.
- Valued having access to resources and observing hands-on activities using everyday materials.
- Benefitted from receiving ideas, lesson plans and instructional videos to support their future lessons.

Other Project implications

Primary Science Curriculum

The project identified the limited amount of time allocated to science as a major factor which limits and restricts the amount of science taught in the primary school. Teachers also reported finding it challenging to plan and teach science lessons for certain topics.

Initial Teacher Education

The focus on practical teaching increased the student teachers' confidence in classroom teaching, as well as planning and evaluating. The fact that the project took place over a whole academic year helped students to connect theory with practice. Working in a primary school within the context of a curriculum development partnership made students teachers feel more valued and therefore able to make better use of feedback from their host teacher.

Recommendations

The data from the teachers pre-project confirm the view that primary science continues to have a very low profile in primary schools, despite the many reports and professional development initiatives. Our findings describe the benefits for pupils, student teachers and in-service teachers when ITE institutions and schools work together. The findings from this project confirm our belief that the pre and in-service stages of teacher education should be organized so that student teachers and in-service teachers can develop their practice side by side, so that each can learn from this shared experience and from each other, for the benefit of the pupils in their class.

Therefore, based on our findings we recommend that:

- Primary school principals and management should ensure more time for primary science and that a significant number of lessons involve hands-on enquiry-based activities.
- Curriculum advisors should provide more support to help teachers connect 'World Around Us' topics to science concepts and phenomena, and opportunities for enquiry.
- Funding should be made available to encourage and support teachers in their use of everyday resources including disposable resources.
- Initial teacher education programmes should ensure that all student teachers have opportunities to plan, teach and evaluate science lessons in school whilst being fully supported by science specialist ITE tutors and teachers from the host school.

Acknowledgements

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Appendices

Appendix A: Pre-project Confidence Audit

STRANMILLIS UNIVERSITY COLLEGE, BELFAST

Student Teachers Supporting Science in Primary Schools
Audit Primary Bed 1 Student Teachers
(Pre-project)

The aims of this audit are to:

- explore primary student teachers' confidence in teaching science in relation to the GTC professional competences.
- identify professional development needs of student teachers.
- explore primary student teachers' current practice and perceptions of science

The information you provide will be treated in the **strictest confidence**.
It should take **approximately 5 minutes** to complete.

This audit will be completed again at the end of the project to allow for observation of any change in confidence in teaching primary science and in professional development needs and perceptions.

Science Audit for Primary Student Teachers

1. How important do you feel science is in the primary classroom?

___

___

___

___

Some student teachers are more confident than others in their science knowledge, in their teaching of science in the primary classroom, and in their evaluation of lessons in general. **Please give your best estimate** of how confident you feel in relation to the following GTC competence statements:

4 Fully confident

3 OK

2 Not very confident

Need help

	4	3	2	1	Office Use only
Display knowledge and understanding of science	☐	☐	☐	☐	☐
Set appropriate learning outcomes	☐	☐	☐	☐	☐
Plan lessons/ activities that enable all learners (including those with special and additional needs) to meet learning intentions	☐	☐	☐	☐	☐
Evaluate lessons/ activities	☐	☐	☐	☐	☐
Guide the work of other adults to support pupil learning	☐	☐	☐	☐	☐
Create and maintain a safe, interactive and challenging learning environment	☐	☐	☐	☐	☐

	4	3	2	1	
Use a range of teaching strategies and resources, including eLearning where appropriate.	☐	☐	☐	☐	☐
Monitoring learner progress	☐	☐	☐	☐	☐
Use a range of assessment strategies to evaluate learning.	☐	☐	☐	☐	☐
Evaluate lessons taught and use critical reflection to guide future planning.	☐	☐	☐	☐	☐

10. Please indicate what help, if any, you would like from this project in relation to your understanding and teaching of Primary Science.

____

____

____

____

11. Are there any aspects of your professional practice, which you would like the project to develop?

____

____

____

____

Your help in completing this audit is much appreciated ☺

Appendix B: Post-Project Confidence Audit

STRANMILLIS UNIVERSITY COLLEGE, BELFAST

Student Teachers Supporting Science in Primary Schools
Audit Primary BEd 1 Student Teachers
(Post-project)

The aims of this audit are to:

- explore primary student teachers' confidence in teaching science in relation to the GTC professional competences.
- identify professional development needs of student teachers.
- explore primary student teachers' current practice and perceptions of science

The information you provide will be treated in the **strictest confidence**.
It should take **approximately 5 minutes** to complete.

Science Audit for Primary Student Teachers

1. How important do you feel science is in the primary classroom having taught it in school? How (if) has your perception changed?

____

____

____

____

Office Use Only

2. Having taught science in school, please give your best estimate of how confident you now feel in relation to the following GTC competence statements:

4 Fully confident

3 OK

2 Not very confident

1 Need help

	4	3	2	1	Office Use Only
Display knowledge and understanding of science	☐	☐	☐	☐	☐
Set appropriate learning outcomes	☐	☐	☐	☐	☐
Plan lessons/ activities that enable all learners (including those with special and additional needs) to meet learning intentions	☐	☐	☐	☐	☐
Evaluate lessons/ activities	☐	☐	☐	☐	☐
Guide the work of other adults to support pupil learning	☐	☐	☐	☐	☐
Create and maintain a safe, interactive and challenging learning environment	☐	☐	☐	☐	☐

	4	3	2	1	
Use a range of teaching strategies and resources, including eLearning where appropriate.	☐	☐	☐	☐	☐
Monitoring learner progress	☐	☐	☐	☐	☐
Use a range of assessment strategies to evaluate learning	☐	☐	☐	☐	☐
Evaluate lessons taught and use critical reflection to guide future planning.	☐	☐	☐	☐	☐

3. Please indicate how (if) this project has influenced your understanding and teaching of Primary Science.

____

____

____

____

4. Are there any aspects of your professional practice, which the project has developed?

____

____

____

5. What future support might you require in developing your science and technology practice?

____

____

Your help in completing this audit is much appreciated ☺

Appendix C: Year 2 student questionnaire

OF CHEMISTRY

Student Teachers Supporting Science in Primary Schools

Student teachers' Exit Questionnaire

1. Which Key Stage did you teach during this project? Please circle

   FS KS1 KS2

2. Please tick which response best describes your thinking.

Strongly Agree (SA) Agree (A) Not sure (NS) Disagree (D) Strongly Disagree (SD)

Participation in the project has:

	SA	A	NS	D	SD
Increased my confidence in teaching science					
Developed my understanding of primary science concepts					
Developed my classroom management skills					
Developed my lesson planning skills					
Developed my ability to connect my teaching of science to WAU topics					
Developed my ability to evaluate my teaching					
Made me more aware of the benefits of teaching science in the primary schools					
Enabled me to benefit from more support and feedback from my teacher					
Made me feel my teaching was more valued by my teacher					
Helped me to connect learning experiences in College to practice in the classroom					
As a result of this project I will be more likely to teach science in my future teaching					

3. Do you feel your participation in this project has developed your ability to teach primary science? (Please circle your response)

   Yes Not Sure No

How?

4. Did the project develop your practice in any other areas?

5. Which aspect(s) of the project (if any) do you feel were the most beneficial to you?

6. Do you think your conversations and discussions with your teacher were different for science than other subjects? Please explain.

7. Any other comments on your experiences of the project?

Many thanks on taking the time to complete this questionnaire.

Appendix D: Teacher Baseline Questionnaire

Student Teachers Supporting Science in Primary Schools

Teachers' Current Practice and Views on Primary Science

1. Which Key Stage do you teach? (Please circle)
   FS KS1 KS2

2. How much science do you teach on average per week. (Please tick)
   0-30 mins. ☐
   30-60 mins. ☐
   60-90 mins. ☐
   More than 90 mins. ☐

3. Do you think there should be more science in the primary curriculum?
   Please tick Yes ☐ No ☐

4. Do you feel any of the following restrict your teaching of science? (Please tick all that apply and circle the most influential restriction)
   Time allocated to WAU ☐
   Knowledge of science. ☐
   Ideas on how to connect science to topics. ☐
   Resources ☐
   Confidence in teaching science ☐
   Other ☐

5. Have you had any science focussed CPD within the last 5 years?
   Yes ☐ No ☐

   If yes please detail:

6. Would you like to have science focussed CPD?
   Please tick Yes ☐ No ☐

7. What do you feel would best support your teaching of science?

8. Any other comments on your views or teaching of primary science.

Many thanks for taking the time to complete this questionnaire.

Appendix E: Teacher Questionnaire (Post-project)

STRANMILLIS

ROYAL SOCIETY OF CHEMISTRY

Student Teachers Supporting Science in Primary Schools.

Teachers' Practice and Views on Primary Science Post-project

Thank you for taking part in the project. We would greatly appreciate if you could provide us with some feedback.

1. Do you feel the project has been useful? Please circle your response
   Yes   Not Sure   No

   Please explain

2. As a result of the project do you think you will teach more science? Please circle your response
   Yes   Not Sure   No

   Please explain

3. As a result of this project do you think you might be more likely to include hands-on activities in your science lessons?

Yes Not Sure No

Please explain

Any other comments?

4.

Many thanks for taking the time to complete this questionnaire.

Appendix F: List of Participant Schools

Abbey PS
Abbots Cross PS
Academy PS & NU
Alexander Dickson PS
Andrews Memorial PS
Ashgrove PS
Aughnacloy PS
Ballinderry PS and NU
Ballougry PS
Ballycarrickmaddy PS
Ballycraigy PS
Ballyhenry PS
Ballyholme PS
Ballykelly PS & NU
Ballymacash PS & NU
Ballymacrickett PS
Ballynahinch PS & NU
Ballysillan PS & NU
Ballysillan PS & NU
Ballywalter PS
Bangor Central Int. PS
Belvoir Park PS & NU
Ben Madigan Prep. School & NU
Black Mountain PS
Blythefield PS
Brackenagh West PS
Bridge Int. PS
Brookeborough PS
Brooklands PS & NU
Broughshane PS & NU
Buick Memorial PS & NU
Cairncastle PS
Campbell College Junior School
Camphill PS
Carnaghts PS
Carnlough Controlled Int. PS
Carnmoney PS
Carr PS & NU
Carrickfergus Central PS
Carrowdore PS
Carrowdore PS
Carr's Glen PS & NU
Carryduff PS
Castle Gardens PS
Castleroe PS
Cavehill PS
Christ the King PS
Christ the Redeemer PS
Churchtown PS
Clandeboye PS
Cliftonville Int. PS & NU
Clough PS
Cloughmills PS
Comber PS & NU
Comber PS & NU
Cookstown PS
Corran Int. PS & NU
Crawfordsburn PS
Crawfordsburn PS
Crumlin Int PS

Cumran PS
Currie PS
D H Christie Mem PS
Dickson PS & NU
Donacloney PS & NU
Donaghadee PS & NU
Dromore Central PS
Dromore Road PS
Dunclug PS
Dundonald PS & NU
Dundonald PS & NU
Dungannon PS
Dunmurry PS & NU
Edenbrooke PS
Edenderry PS
Edenderry PS
Euston Street PS & NU
Fair Hill PS & NU
Finaghy PS
Fort Hill Int PS & NU
Forth River PS
Fourtowns PS
Friends' Prep. School
Fullerton House Prep. School
Gilnahirk PS
Glasswater PS
Glencraig Int. PS
Glengormley Int. PS
Glenwood PS
Gracehill PS & NU
Grange Park PS
Greystone PS
Hamiltonsbawn PS
Hardy Memorial PS
Harmony PS & NU
Harpur's Hill PS
Harryville PS & NU
Hart Memorial PS
Hazelwood Int. PS & NU
Hollybush PS & NU
Holy Child PS & NU
Holy Cross Boys' PS
Holywood PS
Inchmarlo Prep. School
Iveagh PS
Kells & Connor PS
Kilbride PS
Kilbroney Int. PS
Kilcooley PS & NU
Kilcooley PS & NU
Kilkeel PS
Killowen PS
Killowen PS & NU
Killowen PS & NU
Kilmaine PS & NU
King's Park PS
King's Park PS & NU
King's Park PS & NU
Kirkinriola PS
Kirkistown PS
Knockahollet PS
Knockbreda PS
Knockmore PS
Knockmore PS

Knocknagoney PS & NU
Knocknagoney PS & NU
Largymore PS
Leadhill PS
Ligoniel PS
Lisburn Central PS & NU
Lisnadill PS
Lisnasharragh PS
Londonderry Model PS & NU
Loughview Int. PS & NU
Lurgan Model PS & NU
Magherafelt PS
Maguiresbridge PS
Malvern PS
Markethill PS
McClintock PS
Meadow Bridge PS
Mill Strand Int. PS
Millennium Int. PS & NU
Millisle PS & NU
Millquarter PS
Moneymore PS & NU
Mossgrove PS & NU
Moy Regional PS
Moyle PS & NU
Nettlefield PS
Newcastle PS & NU
Newtownards Model PS
Olderfleet PS
Omagh County PS
Omagh Int. PS & NU
Orchard County PS

Our Lady's PS
Phoenix Int. PS & NU
Portrush PS
Provider Postal Name
Rasharkin PS
Rathcoole PS & NU
Rathmore PS & NU
Rathmore PS & NU
Rosetta PS & NU
Rowandale Int. PS
Rowandale Int. PS
Royal School Armagh Prep.
Seaview PS & NU
Seaview PS & NU
Seymour Hill PS
Silverstream PS & NU
Springfield PS
Springhill PS
St Anne's PS
St Bernard's PS
St Bride's PS & NU
St Brigid's PS
St Bronagh's PS
St Colman's PS
St Comgall's PS
St Jame's PS & NU
St Joseph's PS
St Joseph's PS & NU
St Kieran's PS
St Mary's PS
St Mary's PS
St Mary's Star of the Sea PS

St Patrick's PS

St Patrick's PS

St Vincent de Paul PS

Straidhavern PS

Stranmillis PS & NU

Sullivan Upper Prep. School

Sunnylands PS

Sunnylands PS

Tandragee PS

Taughmonagh PS & NU

Tildarg PS

Towerview PS & NU

Towerview PS & NU

Victoria College Prep. School

Victoria Park PS

Victoria PS

Walker Memorial PS

Wheatfield PS & NU

Whiteabbey PS

Whitehead PS & NU

Windmill Int. PS & NU

Woodburn PS

Appendix G: Example of Lesson Plans and Evaluations at Key Stage 1

STRANMILLIS UNIVERSITY COLLEGE
A College of Queen's University Belfast

ROYAL SOCIETY OF CHEMISTRY

Student Teachers Supporting Science in Primary Schools.

Class Primary 4 Lesson No. 1

Topic: <u>Weather</u>

Lesson Title: <u>Rainbow Walking Experiment</u>

WAU Strand and statement:

'Change over Time'-

- 'The origins of all materials can be traced back to the earth, the air, the water, or living things (plants and animals).'

"Movement and Energy'-

- 'An object will remain stationary unless a push or pull is applied.'
- 'The degree of a push or pull may bring about a change in the movement of an object the push or pull may speed up or slow down.'
- 'The amount of grip between two surfaces will affect movement in different ways.'

Lesson in a sentence:

Pupils will place primary dyed water into three cups and with paper towels in cups make a 'walking rainbow'.

Science concept: '*How water can move between cups and make a range of colours.'*

Science Enquiry Skills:

- Observation: Use the senses to make observations and provide descriptions of what they notice.

- Predicting: Make simple predictions and see possibilities. Give opinions and reasons.

-Doing: Talk about fair and unfair when testing.

-Evaluating: Talk about what they have done and what they have learned based on their observations and first-hand experiences

Introduction of lesson:

This lesson will be a continuation of weather WAU lessons. The pupils will discuss what rainbows are, what colours they are made of.

They will then discuss how this is a science lesson, they will discuss what a prediction is, how we are going to make one.

Pupils make their prediction.

Pupil Activity:

Pupils will work in groups of 4 or 5 and they will create walking rainbows. They will be given 7 plastic cups for each group. The 1st,3rd and 7th cup will be filled ¾ with water.

Pupils will put red food colouring in the 1st and 7th cups.

Pupils will put yellow food colouring in the 3rd cups.

Pupils will put blue food colouring in the 5th cup.

Pupils will place paper towels in each cup and observe the water walking across cups and making a rainbow

Resources

- Recording sheets
- Food colouring
- Cups
- Paper towels

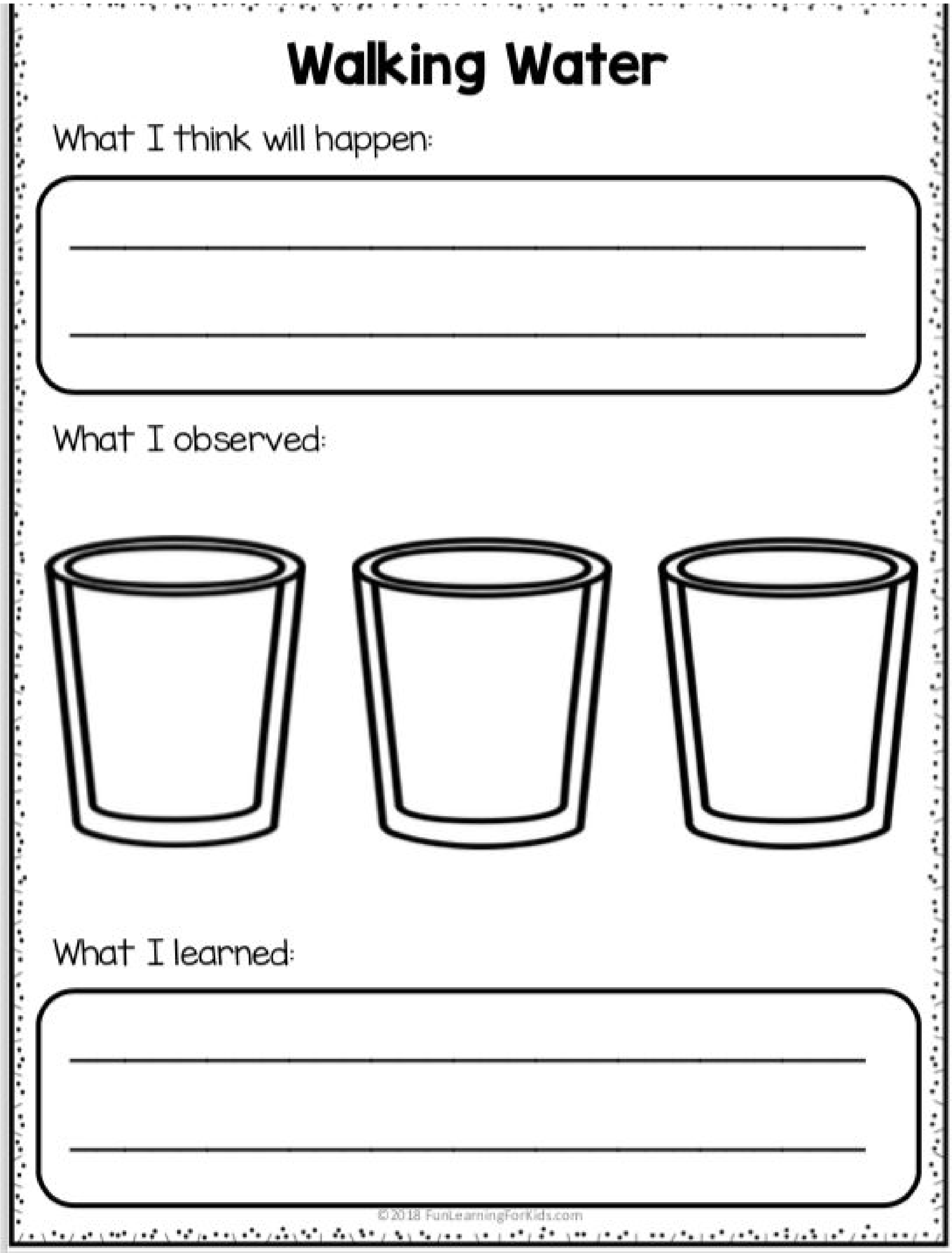
Management of activity

- **Group Size:** This was a class of 24, the pupils were split into groups of 4 groups of 5 and 1 group of 4. So only 5 groups were being manged at one time.
- **Timing:** The lesson was in the final slot within the short days, so there was 45 minutes for this lesson. 10-minute Introduction and 10-minute plenary, so 25-minutes to conduct the experiment.
- **The Role of the Teacher:** Throughput the lesson will be enable discovery. The teacher will discuss the Rainbows with the pupils; asking many open-ended questions in order for the pupils to learn how water and paper-towels will work to

make the water move and how the food dye will mix to create a rainbow, through the experiment and observation.

Plenary Activity

Pupils will complete their worksheets about their rainbow experiment.



Walking Water

What I think will happen:

What I observed:

What I learned:

STRANMILLIS UNIVERSITY COLLEGE
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ROYAL SOCIETY OF CHEMISTRY

Student Teachers Supporting Science in Primary Schools.

Class Primary 4   Lesson No. 2

Topic: Weather

Lesson Title: Wind

WAU Strand and statement:

'Change over Time'-

- 'The origins of all materials can be traced back to the earth, the air, the water, or living things (plants and animals).'

"Movement and Energy'-

- 'An object will remain stationary unless a push or pull is applied.'
- 'The degree of a push or pull may bring about a change in the movement of an object the push or pull may speed up or slow down.'
- 'The amount of grip between two surfaces will affect movement in different ways.'

Lesson in a sentence:

Pupils will place recourses into their jars and using hand force they will swirl the jar in order to form a tornado.

Science concept: '*How does a tornado form within a jar?'.'*

Science Enquiry Skills:

- Observation: Use the senses to make observations and provide descriptions of what they notice.

- Predicting: Make simple predictions and see possibilities. Give opinions and reasons.

-Doing: Talk about fair and unfair when testing.

-Evaluating: Talk about what they have done and what they have learned based on their observations and first-hand experiences

Introduction of lesson:

This lesson will be a continuation of weather WAU lessons. The pupils will discuss wind. Where does it come from?
I will then read book on wind, and how it effects the 5 senses.
As a class we will go through wind PowerPoint.

Pupil Activity:

Pupils will make predictions about what the resources will do and how they relate to tornados.

Pupils in pairs make their tornados in a jar.

Pupils will complete worksheet.

Resources

- Interactive whiteboard
- Jar
- Water
- Food colouring
- Fairy liquid
- Glitter
- Vinegar

Management of activity

- **Group size:** This was a class of 24, the pupils were split into groups of pairs. 1 jar per pair.
- **Timing:** The lesson was 1 hour long. 10-minute Introduction, 40-minute activity and 10-minute plenary. Throughout the main activity the children will be reminded of the remaining time to ensure they stay on task.
- **Role of the Teacher:** Myself, the class teacher and classroom assistant where all the to aid the learning process. The role of the teacher throughput the lesson will also be to enable discovery. The teacher will discuss the tornados with the pupils; asking many open-ended questions in order for the pupils to learn how resources and force combine to form a tornado, this is done through the experiment and observation e.

Student Teachers Supporting Science in Primary Schools.

Evaluation of impact of lesson on pupils.

Indicator	Rating (H,M,L)	Comments
Children's Motivation	H	The pupils were very motivated to participate in the lessons. The pupils had very little science experience, so where very excited to be involved with carrying out the experiments.
Children's Confidence	H-M	I observed mixed results across the class regarding to children's confidence. A majority of the class were confident and took control in the "Water Walking" lessons, however some pupils within the groups stood back. They weren't as confident in taking part in observing or adding water in the specific cups. The children's confidence seemed more apparent in paired 'tornado in a jar' lesson, I think maybe was due to them working in pairs, so the smaller group allowed more participation.
Children's Observation and Communication Skills	M	As a whole the pupils communication skills were good. They managed to communicate very well in the paired 'tornado in a jar' lesson, again I think this smaller team worked more effectively for my class. However, observation skills were overall more accurate in the "Water Walking" lesson, pupils were able to correctly identify what was happening. This could be due to having previous knowledge of rainbows and the names of colours. While pupils had never had a lesson on wind before my science lesson of 'Tornado in a jar'.
Children's Predicting	M-L	The children's predicting ability was medium to low across the class. Part of their learning was to know what predicting was. So, they knew was a prediction was, however the majority of the class could not come up with ideas for what

		would happen. Many used the same ideas that had been discussed by other pupils in the class.
Problem-solving	L	Problem solving was very low within this class across the curriculum. It was very apparent that the pupils lacked this skill when completing science. They struggled to take initiative and carry out the experiments. I had provided image instructions upon the board for the pupils to follow as well as explaining it before they started but I still got nearly every pupil asking me what to do next or what to do if they spilled water and so on. This was not unexpected as the pupils reacted the same with every lesson they were taking part in.
Decision-Making	L	The issues with decision-making were the same as problem solving in this class. As many could not decide what to do next without confirmation from myself or another adult. They overall struggled with independence and feeling confident enough to make decisions. For example, many struggled with deciding if they wanted their rainbow cups to be in a straight line or a circle formation. This resulting in every single group following what I explained in my introduction and doing a straight-line rainbow.

1. Based on your observations during your two lessons please indicate as High (H), Medium (M) or Low (L) the overall rating for the class. See the supporting QLI document for indicators. Please include some explanatory comments.

Evaluation of Teaching

Please comment on the following, reflect on your role and include examples of classroom incidents to support your account.

1. Did pupils engage in learning?

The pupils within my class were very engaged in the science learning. On my first day with the P4 class I told them we would be partaking in science lessons to do with weather and they were all very visually excited. I then was asked daily when we were having science. This meant when I carried out these two science lessons the pupil's engagement was very high. They listened intently to the instructions and followed them well. When it came to the experiments all the pupils wanted to take part. They all crowed around their ‘Walking rainbow’ and were very intrigued to watch the colours change and the water move. This experiment wasn’t as instantaneous as the ‘Tornado in a jar’ so I was surprised by how many were intrigued and very content to watch the water slowly move between the number of cups.

2. Were pupils interested and enthusiastic?

As noted previously, the pupils had very little science experience, so were very excited to be involved with carrying out the experiments. This resulted in them being extremely interested in what was happening. They all were so enthusiastic about their ‘Tornado in a jar’. Once they noticed their tornado forming the interested comments begun. The classroom was filled with excited conversations. “Miss, look at my tornado”, “Pupil X look how well ours worked!”, “Mine worked!”, “Wow, look at the bubbles swirling round.” They listened well and were able to repeat back the learning intentions at the end of both lessons. They also accurately filled in their worksheets regarding what they had noticed and learnt.

3. Did pupils develop an understanding of science concepts or ideas?

The pupils were very excited to carry out the science experiments and observe what was happening. They were also engaged in hearing the explanations for how the water moved between the cups and how the colours mixed with water to create a rainbow effect. They also listened well when I explained how the resources combined with force created a tornado. However, this was quite a low ability class so while to pupils were enaged in the learning I don’t think they were fully able to grasp the concepts being taught to them. I think they may have taken away what happened in the lesson rather that why those things happened in the lesson. This issues was tackled by having a follow up questions in the introduction of the next WAU lesson. Also, concepts and science terms were incorporated into their WAU linked literacy lessons.

4. Which enquiry skills did pupils develop?

The pupils learnt a range of key enquiry skills. A key aspect of enquiry that they obtained was the ability of predicting; they had to make simple predictions, see possibilities, give opinions and reasons. They had to explain on their worksheets how they thought the resources would make a rainbow. They also had to make a predict for how they though they could make a tornado. Another enquiry skill they were learning was oobservation, they used a range of the senses to observe. In the rainbow walking experiment, they used sight to watch the water moving between the cups and to note the colours mixing and changing into new colours to form a rainbow. They also were able to touch the once dry paper towel and notice throughout experiment the paper became continually more wet as the water moved along it. The sense of smell was used in the 'tornado in a jar' as pupils smelt the vinegar and fairy liquid as it went into the jar. Finally, at the end of each lessons they practiced the skill of evaluating they had to talk about what they have done and what they have learned based on their observations and first-hand experiences, for example how the water moved along paper towels and mixed to form different colours; and how the vinegar and fairy liquid mixed with force caused the tornado to form in the jar.

5. **Did the experience develop your teaching skills? In which areas?**

These lessons developed my teaching skills in a number of different ways. The main one was within the ability to manage the classroom. As discussed above the pupils were very enthusiastic about these lessons and spoke aloud a lot about their observations. This meant the classroom was very loud and there was a lot going on at the one time. This meant I had to make sure I had a good presence in the room and was both listening and responding to the observations being directed at me but also still observing the other groups as they worked to make sure everything was being carried out safely and appropriately. Another key develop in my teaching was the ability to explain harder science concepts to a P4 class. The concept of how wind is formed is quite complicated so in teaching this lesson I had to make sure the lesson was simplified while still getting the main ideas cross; so the pupils actually learnt how wind was formed and weren't sitting confused by the strange and harder language and ideas they had never heard of.

Appendix H: Examples of Key Stage 2 Lesson Plans and Lesson Evaluations

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Student Teachers Supporting Science in Primary Schools.

Class P5-7 Science lesson No. 2

Topic: Vikings

Lesson Title: Absorption of water by different materials

WAU Strand and statement: Science – Place: Why materials are chosen for their use.

Lesson in a sentence: Children test and compare the absorption of water by a range of materials.

Science concept: Absorption

Science Enquiry Skills: Carrying out experiments, making predictions, observing and measuring and recording data.

Introduction of lesson: How did parents in Viking times make nappies? Think-pair-share about natural absorbent materials pupils can think of. Teacher explains task by showing materials, modelling method for testing how much water each material absorbs and writing the steps as a class. Predict absorbance as a class by voting. Rank materials on board.

Pupil Activity: Children work in threes, taking turns. One child holds the material in their hand. Pour water over material 15ml at a time. When the child feels water coming through the material calculate the water absorbed. Record water absorbed for each material. Repeat to test all materials.
Find out which was most effective at absorbing water. Discuss and share findings. What would be the best option for Viking parents? Teacher should model bar chart. Children complete bar chart of results.

Resources: Moss, straw, cotton wool, sponge, nappies, jugs of water, tablespoons, table of results (see below)

Management of activity: The class of 22 pupils should be split into 6 groups of 3 and 1 group of 4. This activity should be set up outside if possible. Each group will have 1 handful of moss, 1 handful of straw, 1 handful of cotton wool and 1 sponge. The group members should rotate their roles for each material. Every pupil should have a turn at holding a material, pouring water and recording tally marks. Pupils should record their results in the table (see below) before tidying up and coming inside to transfer the results into a bar chart.

Plenary Activity: Compare the results in the bar chart (acknowledge that not all results will be exactly the same) with class prediction. Discuss results and evaluate which material is most and least absorbent and which would have been the most effective natural material to use as a Viking nappy. Then, the teacher should let the children predict how much water a nappy holds. The teacher should let pupils take it in turns to pour 100ml water onto the nappy and should let the pupils feel the nappy when it is full. Discuss observations and compare result with predictions.

Testing absorption of materials

Find the best material for a Viking nappy!

Material	Number of 15ml spoons poured.	Total volume absorbed *(Number of spoons poured x 15mls)*

Which material was most absorbent? ________________

How do you know? ___________________________________

____

Which material would have been most effective for Viking parents to use? ______________________

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Class P5-7 Science lesson No. 1

Topic: Vikings (Preserving food)

Lesson Title: Extracting salt from salty water

WAU Strand and statement: Science – Change Over Time: Changes that occur to everyday substances, for example, when dissolved in water or heated.

Lesson in a sentence: Children dissolve salt into water and predict what will happen when the solution has been left on the radiator for a few days.

Science concept: Dissolving and evaporating.

Science Enquiry Skills: Carrying out experiments, making predictions, observing and interpreting results.

Introduction of lesson: Think-pair-share on how food can be preserved. Salt was quite hard to come by in Viking times, so was unavailable to poorer households (recap using 'What do Vikings eat?' ppt). It can be obtained by mining from salt mines or extracting from sea water. What does extract mean? How could you extract/remove salt from sea water? Teacher should model experiment.

Pupil Activity: Using the equipment and following the instructions on their table, complete the experiment by adding and dissolving salt in the water. After children pour their solutions into the labelled evaporating dishes and leave them on the radiator, ask what they think will happen next.

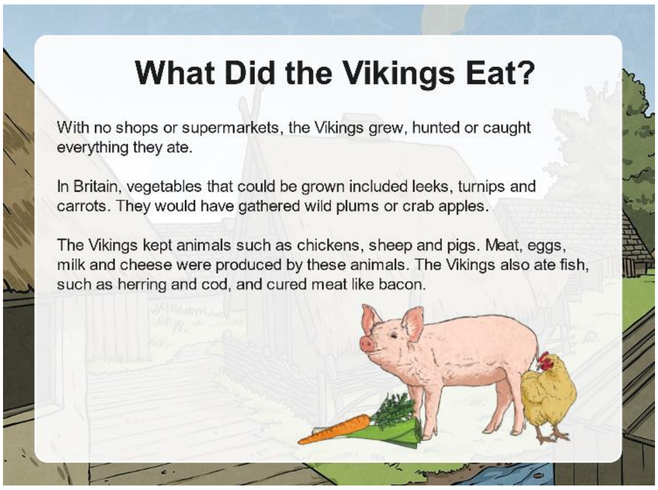
Resources: 'What did the Vikings Eat?' Powerpoint (see below), instructions (see below), beakers of warm water, spoons, salt, evaporating basins, radiator turned on.

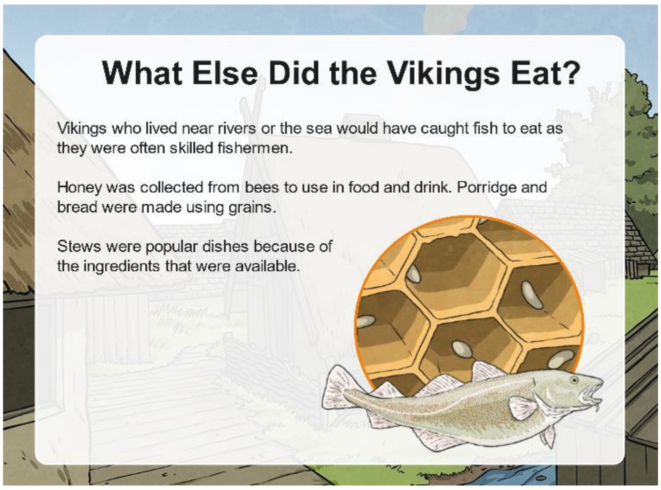
Management of activity: The teacher should model the experiment before the children carry out the task in their groups. Verbal (as well as written) instructions should be very clear so that the pupils can conduct the investigation with understanding. Each group of three should have 1 set of instructions, 1 beaker of water (on a blue paper towel), 1 tub of salt (on the same paper towel to catch any salt spillages), and 1 spoon. When pupils have dissolved approximately 3 teaspoons of salt into the water, they should bring the beaker to the bench beside the radiator when instructed by the teacher. The teacher then helps the children pour their salt solution into a labelled evaporating basin. She tells the children that they now need to think about what will happen to contents of the evaporating dish over the next few days as it sits on the warm radiator. Pupils tidy away the equipment and prepare to share their prediction with the class now.

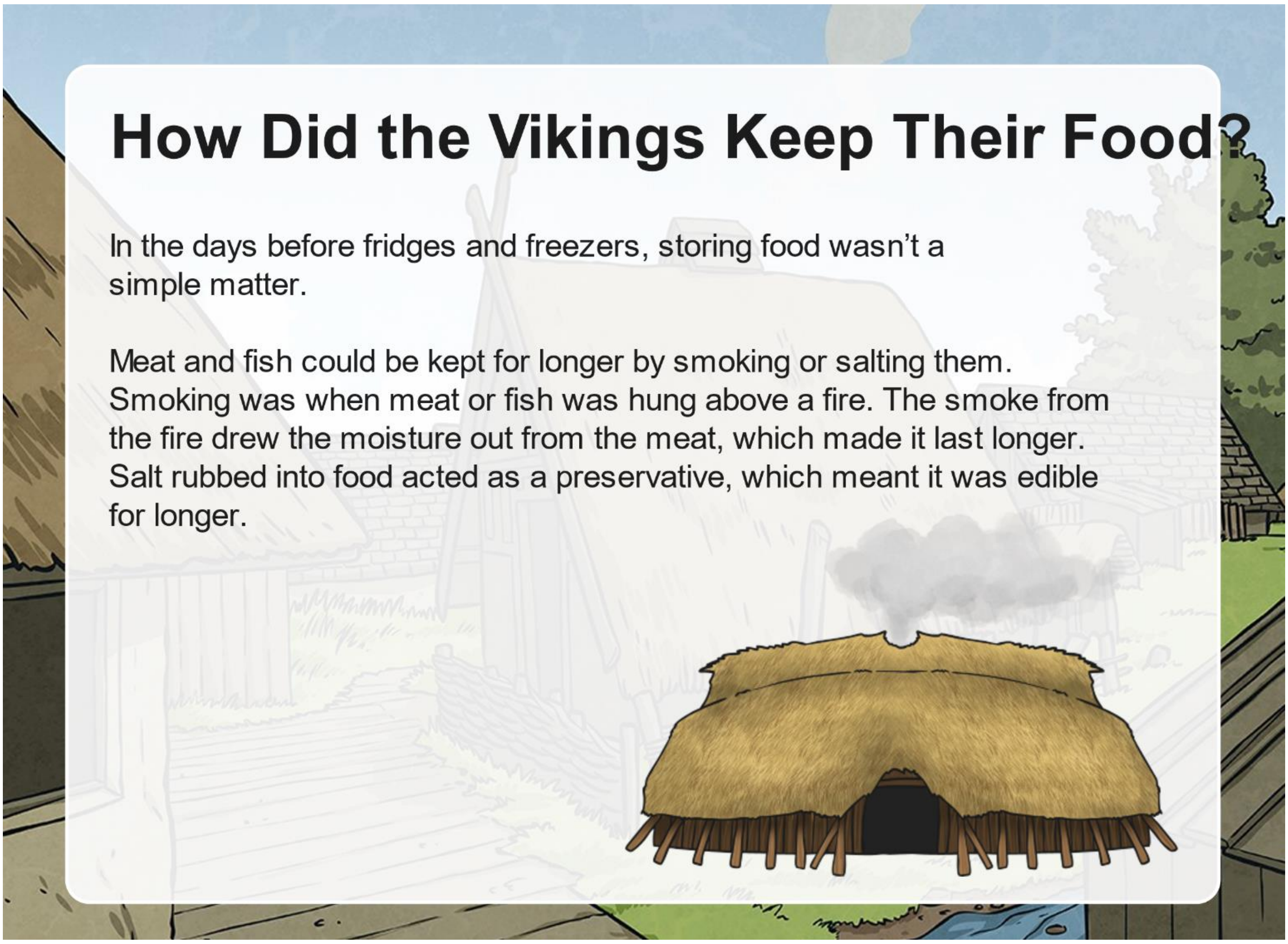
Plenary Activity: Children discuss their predictions and explain their thinking. Why do you think this will happen? Why might the experiment not work? Children write down their predictions.

PowerPoint Resource

See below the three key slides from the 'What did the Vikings eat' PowerPoint.
The enlarged slide is the one most relevant to today's lesson.






How Did the Vikings Keep Their Food?
In the days before fridges and freezers, storing food wasn't a simple matter.
Meat and fish could be kept for longer by smoking or salting them. Smoking was when meat or fish was hung above a fire. The smoke from the fire drew the moisture out from the meat, which made it last longer. Salt rubbed into food acted as a preservative, which meant it was edible for longer.

Salty water

1. Half-fill a beaker of water.
2. Carefully set the beaker on your paper towel.
3. Place a tub of salt on your paper towel.
4. Put 1 teaspoon of salt into the water.
5. Stir the solution for approximately 1 minute until the grains of salt have <u>dissolved.</u>

   (This means it looks like they have disappeared.)
6. After this, put another teaspoon of salt into the solution.
7. Stir for 1 minute, until the grains of salt have dissolved.
8. After this, add less than 1 teaspoon of salt to the solution.
9. Stir for 1 minute, until the grains of salt have dissolved.
10. After the teacher calls your group, one person needs to pour any leftover salt from the tub into the teacher's container.
11. Another person needs to bring the beaker of salty water to the teacher for it to be poured into an evaporating dish.
12. Leave the evaporating dish near a radiator for a few days and see what happens to the salty water.

Equipment list:

Beaker of water
Tub of salt
Spoon
Paper towel
Evaporating dish

What will happen to the salty water?

I think ____

____

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Evaluation of impact of lesson on pupils.

Based on your observations during your two lessons please indicate as High (H), Medium (M) or Low (L) the overall rating for the class. See the supporting QLI document for indicators. Please include some explanatory comments.

Note from student: The following evaluation focuses on the Salty Water lesson which I did get to teach. I have also included some forward-looking targets in the comments section relating to the lesson on Absorption which I did not get the chance to teach.

Indicator	**Rating (H,M,L)**	**Comments**
Children's Motivation	M	As children in P5-7 informed me, they have not had much opportunity to participate in science lessons in school. They were motivated and they engaged enthusiastically in the lesson by working busily in their groups. The pupils enjoyed the hands-on learning experience and were keen to observe how the salt had dissolved, and what would happen the solution in the next few

		days. However, two pupils could not work responsibly in their group (even with the classroom assistant as their third member) because they purposely added lots of salt, far beyond the point of saturation and did not try to dissolve the salt into the water. So, although they were motivated to use the equipment, they were not motivated to engage responsibly. 20/22 pupils were highly motivated to engage properly with the experiment and I was glad to see that they were excited to find out the result. For the Absorption lesson, I would change some of the groups so that the pupils who did not engage effectively would be separated. Hopefully this change would help all pupils become motivated to take part in the lesson properly.
Children's Confidence	H	In Literacy, the pupils had been focusing on instructional writing and so this understanding increased pupil confidence during the experiment. Modelling the experiment and providing instructions helped to clarify what was expected of the children. Reinforcing the method (through teacher-modelling, verbal reminders and written instructions) enabled the children to work with confidence on what they were required to do. Even though the two pupils did not carry out the experiment properly, I could see that neither of them lacked confidence nor understanding. They simply chose to ignore the clear instructions. When the class teacher returned for the end of the lesson (she had been present when I was modelling the experiment) she told me that the demonstration was helpful in boosting the children's confidence because they could physically see what they were required to do. She also recognised how this was important because the children have not completed science experiments in her class (apart from one with a sub-teacher recently). With the absorption experiment, the task would need to be clearly modelled to the children so that they feel confident in what is expected of them.

Children's Observation and Communication Skills	H	Pupils were well engaged when observing both the demonstration and the results of the experiment. After the teacher-demonstration pupils were able to communicate, with their group, the stages of the experiment. Children were able to listen and respond to comments or questions made by the teacher and other pupils prior to, during and after the experiment (when discussing and justifying their predictions). For the Absorption experiment, observation is a key skill, especially for the person holding the material who must tell their group members when water is no longer being absorbed. It is important, therefore, that sufficient time is allocated to discussion, encouraging pupils to talk about what they observed and discovered. Communicating verbally is vital in this lesson and should be the focus during and after the experiment. Therefore, the teacher may feel that the bar chart of results should be left to another day, ensuring the children are focused on one key concept at a time.
Children's Predicting	M	Some pupils were able to predict the results of the experiment. One P5 pupil was able to explain the results because he had heard about his older brother doing this experiment in secondary school! The pupils listened to and learned from each other's ideas before writing down their final predictions. Although some pupils thought that the salt would disappear, that both the salt and water would disappear, or that nothing would change, I was glad to see that they were thinking about potential outcomes and were trying to justify their opinions to the class. During this experiment, although prediction should be completed as a class, ensure that every child thinks of and shares their own opinion when voting.
Problem-solving	H	After observing the evaporating dishes, pupils were able to problem-solve by making links between cause and effect. Pupils were able to justify any conclusions by explaining that water evaporated due to the heat of the radiator. Some pupils needed

		further explanation/reinforcement with this concept but, by the end of the experiment, all pupils showed a greater understanding of evaporation. Giving pupils the opportunity to generate possible solutions also enhanced their problem-solving skills because the children were able to explore and evaluate a range of potential explanations through class discussion time. During the Absorption task, pupils should problem-solve by investigating why they think some materials absorb more water than others. They should share their ideas about why nappies absorb so much water before having this explained by the teacher.
Decision-Making	H	After pouring the solution into the evaporating dishes, pupils were able to make decisions by listening to the opinions of others in the class, evaluating these inputs and then making their own predictions. Although some pupils took longer to decide on and write a prediction, they showed decision-making skills by choosing the option that seemed more appropriate to them. After observing the evaporating dishes, the pupils used this evidence to decide on a suitable explanation. During the Absorption task, pupils used the results from the experiment to decide which material was most absorbent. Pupils should explain the decision they came to, backing it up with evidence from the experiment.

Evaluation of Teaching
Please comment on the following, reflect on your role and include examples of classroom incidents to support your account.

6. **Did pupils engage in learning?**
   Most pupils (all except two, as explain above) engaged in a responsible, motivated and positive manner. They engaged by listening during the demonstration, carrying out the experiment with understanding, discussing predictions, observing the outcome and discussing results. By the end of the experiment and after discussing the results, pupils had a greater understanding of dissolving and evaporation, showing that they had engaged in learning. I knew that, for learning to take place, this lesson would need to be

very well managed, in relation to equipment, timings and behaviour. I felt that, because of my clear explanations and expectations, the pupils were enabled to engage in productive and purposeful learning.

7. **Were pupils interested and enthusiastic?**
   Pupils were interested and enthusiastic when being introduced to and engaging in the lesson. As pupils are not used to carrying out practical investigations, I was worried that their enthusiasm could lead to over-excitement and potentially cause behavioural issues. However, the vast majority of the pupils remained interested and focused throughout and also showed enthusiasm, particularly when explaining their predictions to the rest of the class.

8. **Did pupils develop an understanding of science concepts or ideas?**
   Pupils develop their understanding of science concepts, most predominantly dissolving. Some pupils were able to explain the concept of dissolving before completing the experiment, but all pupils had a deeper understanding of the ideas after the lesson. This is because the language, as well as being explained, was reinforced throughout the lesson as the pupils engaged in the experiment practically. Rather than simply remembering the definition of 'dissolving' pupils were able to cause salt to dissolve, and observe this process for themselves. The children's understanding of evaporation was also developed. When discussing the results of the experiment, pupils were able to compare these with their previous predictions. Once they had grasped what had happened, children could consider, with the class, why they think this happened. Hearing the various thoughts and ideas enabled the children to consider the most appropriate explanation and, by the end of the discussion, pupils could appreciate how the water had evaporated.

9. **Which enquiry skills did pupils develop?**
   As stated in the lesson plan, pupils could develop their ability to carry out an experiment, make predictions, observe outcomes and interpret results. In carrying out an experiment, pupils could further enhance their communication skills by working with others to complete the task in an efficient and inquisitive manner. They could then use

this curiosity to think about and make predictions. In developing this enquiry skill, pupils learn to think independently and justify their opinions with relevant reasons. Pupils were then able to reflect on their prediction and compare it with the results of the experiment. Discussing the outcome of the experiment helped children to gain further insight into the concept of evaporation and to practise the enquiry skill of interpreting results.

10. Did the experience develop your teaching skills? In which areas?

Through this lesson the main skills I developed were communication (by giving clear demonstrations, instructions and guidance) and classroom management (by expressing clear expectations and by having resources well prepared). I feel that I have developed a greater awareness of how modelling a task can promote effective learning by providing a clear demonstration of what is expected during the main activity (Competence 6). This meant that the children were confident when completing the task and when subsequently sharing their predictions with the class. This confidence and enthusiasm helped to promote pupil voice during the plenary discussion, establishing an effective learning environment (Competence 7). Furthermore, as I knew this task could make for a rather busy classroom, I planned to ask the other adults in the room for support. As the class teacher could not be present during this lesson, I asked the classroom assistant to help manage two pupils who found it hard to focus. Although these pupils still refused to follow the proper instructions, I was able to develop the skill of seeing where the adult support should be deployed to in the classroom (Competence 14).